McNeill et al. 1997

JARBIDGE RIVER WATERSHED ANALYSIS

JARBIDGE RANGER DISTRICT
HUMBOLDT-TOIYABE NATIONAL FORESTS

ANALYSIS CORE TEAM:

MICHAEL E. MCNEILL, TEAM LEADER
JAY FREDERICK, BIOLOGIST
BONNIE WHALEN, GIS SUPPORT

SPECIALIST TEAM MEMBERS:

Chris Butler, Hydrologist
Fred Frampton, Archaeologist
Kathy Ramsey, Fish Biologist

Additional Input provided by:

Gary Johnson, Nevada Division of Wildlife, Region II
Jim Klott, Jarbidge Resource Area, Idaho BLM
Bruce Zoellick, Idaho State BLM

JARBIDGE CANYON WATERSHED ANALYSIS

TABLE OF CONTENTS

DATA CHARTS AND GIS OVERLAYS

Data Charts:

Jarbidge Canyon Watershed Analysis
V 2.3 05-21-97

Chapter One - Characterization of the Watershed

Introduction

The intent of this analysis is fourfold: 1) document existing conditions within the Jarbidge River watershed (JRW); 2) provide an overview of ongoing activities within the watershed; 3) make recommendations for incorporation into National Environmental Policy Act (NEPA) analysis of future project proposals within the watershed; 4) identify any weakpoints in existing data. This document is not a decision making document nor is it done within the NEPA framework. It's purpose is to provide decision makers and interdisciplinary teams (IDT) with base-line data and recommendations at the watershed scale. This information will be used during NEPA analysis of project proposals as an aid to displaying environmental effects as well as a source of recommendation for project implementation decisions.

The watershed lies within the geographic range of the inland Native Fish Environmental Analysis (INFISH) and was included in the Decision Notice and Finding of No Significant Impact (DNFONSI) signed on July 28, 1995. The adopted alternative provides interim Riparian Management Objectives (RMO) and guidelines for Riparian Habitat Conservation Areas (RHCA). In the absence of a watershed analysis, they would apply to ongoing activities in the JRW. The DNFONSI requires a watershed analysis and establishment of site specific RMO's and RHCA descriptions for new project proposals. The Forest Service is proposing to reconstruct portions of an access road between the Pine Creek Campground and the Snowslide Trailhead. Located in the JRW, segments of this road were severely damaged by spring flooding in 1995. The proposal to reconstruct the road is the basis for initiating this analysis. For the purpose of this analysis, **Jarbidge River** refers to the west or main stem of the river above the confluence with the East Fork Jarbidge River. **East Fork** refers to the East Fork of the Jarbidge River above the confluence.

The INFISH DNFONSI defines watershed analysis as forming the basis for evaluating cumulative effects, defining watershed restoration needs, goals and objectives, implementing restoration strategies and monitoring the effectiveness of watershed protection measures. Although not a NEPA process, watershed analysis employs an IDT approach, especially geomorphology, hydrology, aquatic and terrestrial ecology, and soil science. This analysis was conducted by an IDT using protocol from *Ecosystem Analysis at the Watershed Scale*, (Version 2.2, 08-95). This guide displays a six-step process for conducting analysis at the watershed scale and organization of this document follows that process. Those steps are:

1. Characterization of the watershed. This step identifies the dominant physical, biological, and human processes or features of the watershed.

2. Identification of issues and key questions. This step focuses the analysis on the key elements of the ecosystem that are most relevant to the management questions and objectives, human values, or resource conditions within the watershed.

3. Description of current conditions. This step develops information, more detailed than the characterization of step 1, relevant to the issues and key questions identified in step 2.

4. Description of reference conditions. This step explains how ecological conditions have changed over time as a result of human influence and natural disturbances.

5. Synthesis and interpretation of information. This step compares existing and reference conditions of specific ecosystem elements and attempts to explain significant differences, similarities, or trends and their causes.

6. Recommendations. This step brings the results of the previous five steps to conclusion. This step also identifies data gaps and limitations of the analysis.

The above steps are presented in this document as Chapters One through Six.

The Jarbidge River Watershed

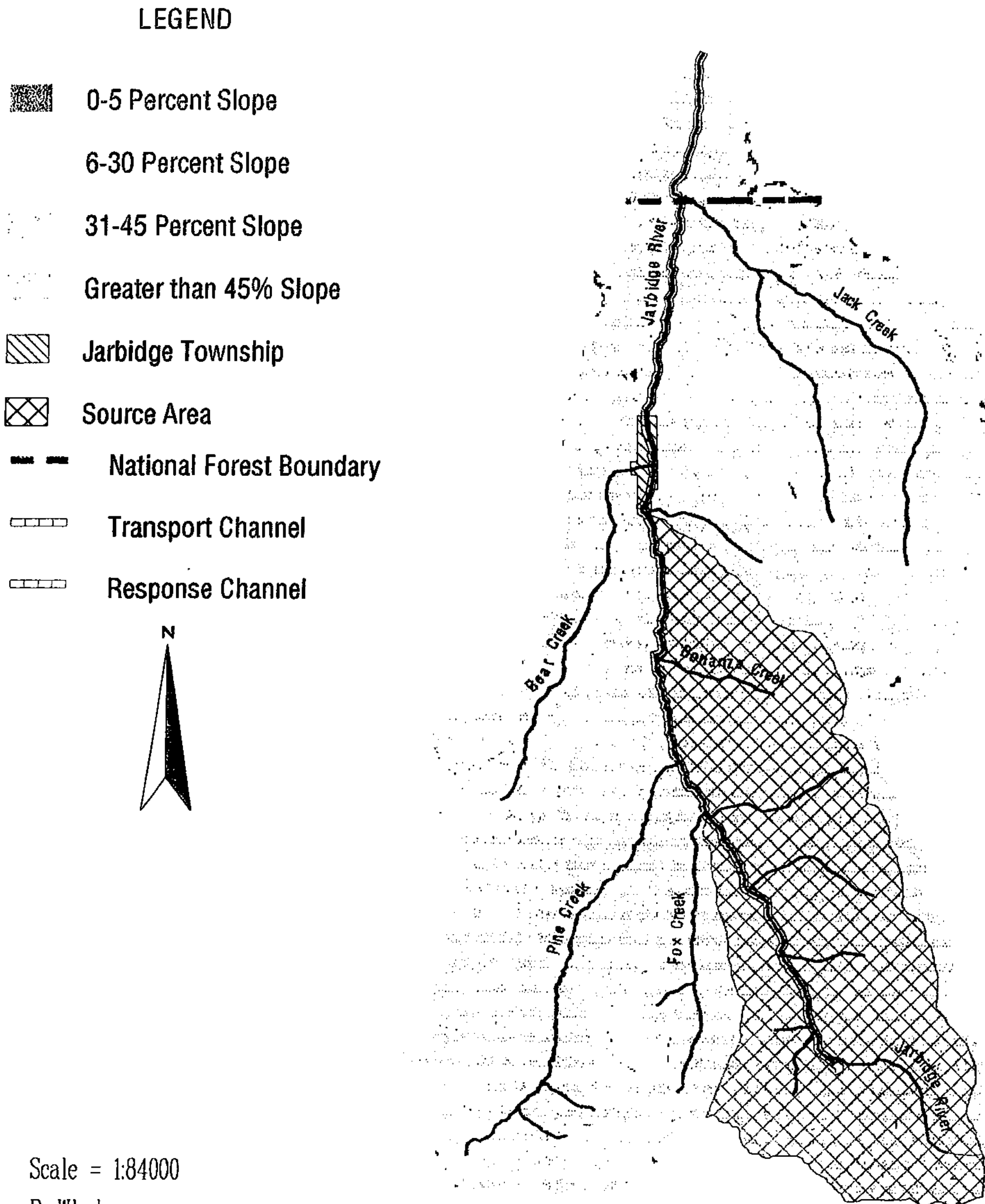
Physical Setting: The JRW is in the southeast portion of the Bruneau River subbasin, Snake River Drainage. This watershed varies in elevation from 4980 feet at the confluence of the East Fork in Idaho to 10839 feet at Matterhorn Peak in the Jarbidge or Crater Mountains (Figure 1.6). At the Humboldt National Forest boundary, the elevation is approximately 5500 feet. The Jarbidge River exceeds 18 miles in length.

The Jarbidge River has 6 perennial fish-bearing tributaries: Buck, Jack, Deer, Bear, Pine, and Fox Creeks. Moore, Bonanza, Bourne and Dry Gulch(s) are intermittent or ephemeral, contributing flow to the Jarbidge River on an seasonal basis. The total perennial stream mileage including subasins and main channel of the Jarbidge river exceeds 42 miles.

Most of the river flow is derived from winter snowpack in this high mountain watershed, with annual peak flows corresponding with spring snowmelt, typically in May and June. Low flow generally occurrs from November through January. The river is perennial in the main channel though flow may become very low during years of extended drought.

The upper JRW is very active erosionally; mass-wasting is a dominant erosional process. Several types of mass wasting have been identified, including debris avalanches, debris torrents and earth slumps. Review of historic aerial photos indicate that recent (since 1984) side channel debris torrents and debris avalanches have occured on the side slopes and in side drainages with a west, southwest aspect. Colluvial and alluivial material has accumulated in the narrow Jarbidge River valley bottom forming wide cobble and gravel bars and influencing hyrologic flow regimes. On a

Slope - West Fork of Jarbidge River



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B. Whalen

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FIGURE 1.1

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Geology - West Fork of Jarbidge River

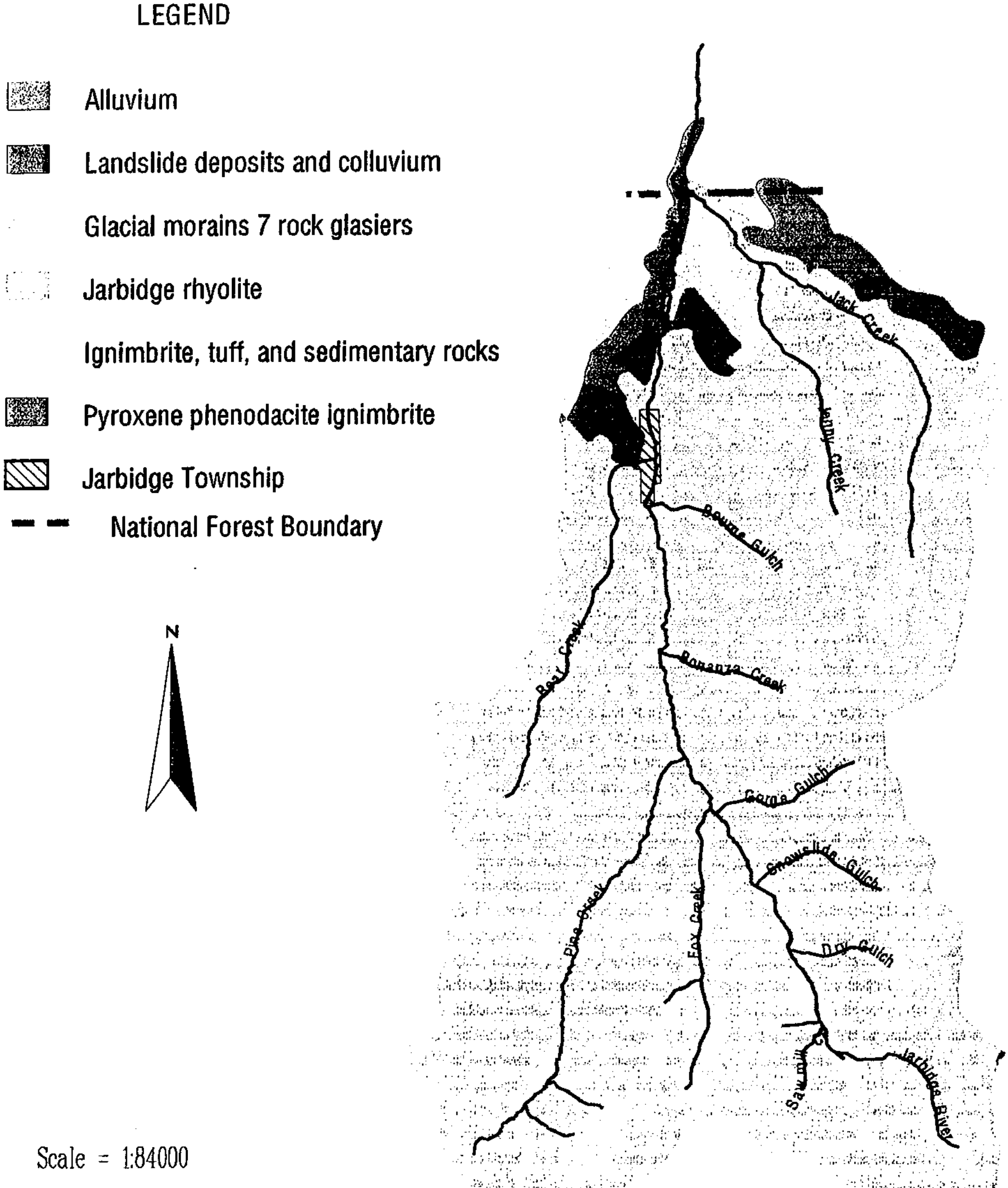

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FIGURE 1.3

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more chronic basis, shallow soils on moderate to steep valley slopes allow for continual downslope dry ravel, sheet erosion and minor gullying. Periodic spring rain-on-snow events contribute to the downslope movement of rock debris.

The moisture regime in the watershed can be characterized as semi-arid at the National Forest boundary to sub alpine at the higher elevations, with annual precipitation ranging from 12 to over 20 inches. Although both regimes are snow-dominated, a significant portion of the precipitation falls as spring and fall rain storms. The steep west face of the Jarbidge Mountains influences precipitation on a topographically localized level. When atmospheric circulation forces an air mass to rise over the Jarbidge Mountains, orthographic precipitation falls on the mid and upper west slope. The area that recieves the greatest amount of orthographic precipitation coincides with the *source* areas for sediment as described in Figure 1.1

Geology: Geology of the JRW is dominated by Jarbidge rhyolite occupying 76% of the surface acres within the watershed. Rhyolite is a light-colored, fine-grained volcanic rock with a very high (more than 70%) silica content. Similar to the coarser grained granites in mineralogy and chemistry, rhyolite tends to be very viscous because of its high silica content, and upon eruption it generally forms steep-sided domes and plugs. Gas-rich rhyolite, however, erupts violently to form welded tuffs, or ignimbrites, and may spread out over great distances.

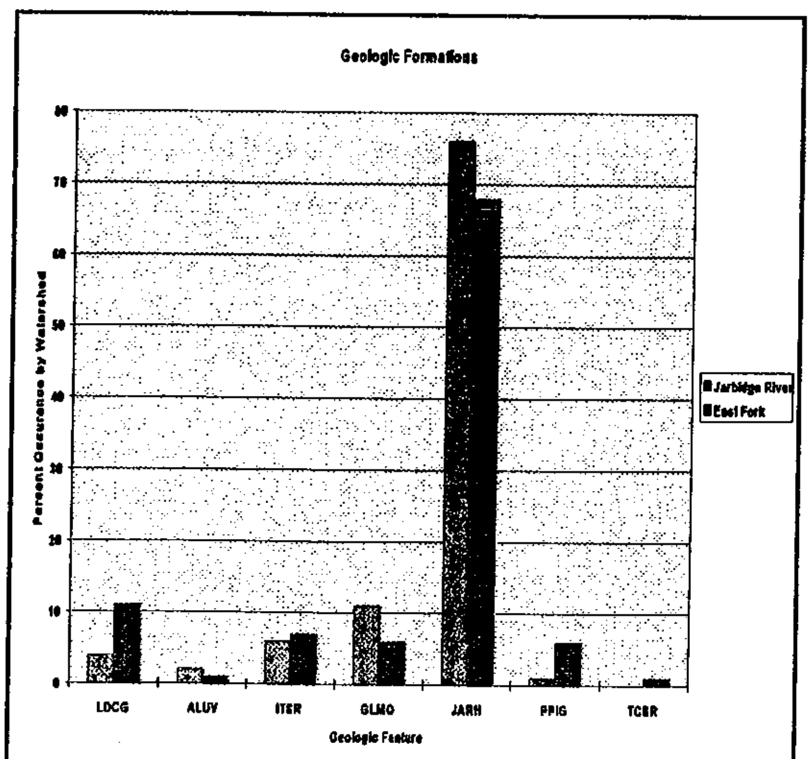

Figure 1.2. Geologic formations in the Jarbidge and East Fork Watersheds. Comparison of geologic feature similiarity by percent occurrence within the paired watersheds.

JRW geology includes sediments of dust, ash, volcanic glass, and rock fragments of various sizes spread by the force of valcanic explosion. Pyroclastic rocks, fragments of igneous material shot out of volcanoes and deposited as sediments, are considered to be sedimentary rock. Tuff is one of two major pyroclastic rocks. Tuff contains the smaller fragments which form when ejected liquid lava solidifies in flight, and blocks, which are ejected from a volcano as solids. Pyroclastic rocks are chemically unstable, and the minerals within are subject to rapid alteration. One kind of tuff that carries a special name is ignimbrite, or welded tuff, a nonsorted rock deposited from a hot glowing ash flow that moved very rapidly down the volcano, while the particles were still in a plastic condition. As ash flows cool, the plastic material welds these particles together. Ignimbrites are a geologic feature found on approximately 7% of the JRW.

Alluvium, glacial morains, landslide deposits and colluvium occupy the remaining 17% of the JRW. A geology map was prepared for the East Fork watershed to facilitate a paired watershed comparison. Figure 1.2 illustrates the percent occurrence of geologic types as they occur within both watersheds. Geologic features are abbreviated in Figure 1.2 as follows: LDCG - Lanslide deposits, colluvium and gravel; ALUV - Alluvium; ITSR - Ignimbrite, tuff, and sedimentary rock; GLMO - Glacial morains 7 rock glaciers; JARH - Jarbidge rhyolite; PPIG - Pyroxene phenodacite ignimbrite; TCSR - Tuffaceous and clastic sedimentary rock.

One potentially significant difference in geology between the two watersheds is in those geologic types which could be considered as disturbance prone (disturbance prone being defined as landslide deposits, colluvium and gravel, shown as LDCG on Figure 1.2). The East Fork has a percent occurrence of 11% for these types while the Jarbidge has a percent occurrence of 4%.

Soils: Soil data are lacking for the JRW. Third order soil surveys were completed for the Buck Creek Allotment Coordinated Resource Management Plan (CRMP) in 1982. This data can be used as a characterization of soils in the JRW due to the fact that the Buck Creek watershed is immediately adjacent to the JRW on the western boundary.

Characterization of soils above 8,000 is lacking, however, a general description of these soils would include shallow, well drained sandy loams with moderate permeability based on information for similar slopes at lower elevations. A large portion of the barren vegetation cover-type (rock, slides, outcrop) can be found above 8,000 feet. The Buck Creek CRMP soil data provides a good representation for the remainder of elevational zones. A summary of major soil association information follows:

SLOPING PLATEAUS AND TABLELANDS, 6,300-7,300 FEET ELEVATION AND 2% TO 15% SLOPES. Shallow, well drained, with moderately slow permeability. Tending toward stony loam texture.

MODERATELY SLOPING TO STEEP HILLS, TABLELANDS, AND INSET FANS, 6,500-7,900 FEET ELEVATION AND 4% TO 15% SLOPES. Generally shallow , well drained, with moderately rapid permeability and slightly alkaline. These soils under aspen thickets are slightly to very strongly acidic. Includes stony loam, gravelly loam, and loam textures.

FLOODPLAINS AND ALONG MOUNTAIN DRAINAGES, 5,600 TO 8,000 FEET ELEVATION AND 0% TO 4% SLOPES. Deep and stratified with textures ranging from sandy loams to silty clay loams. Salinity not a problem. Slightly acid to slightly alkaline.

GENTLY SLOPING TO STEEP HILLS, 6,000 TO 6,700 FEET ELEVATION AND 2% TO

50% SLOPES. Shallow, well drained, neutral, slowly permeable soils. Stony to stony silt loam texture.

GENTLY TO MODERATELY SLOPING PLATEAUS OR TABLELANDS, 6,000 TO 6,300 FEET ELEVATION, 2% TO 15% SLOPES. Shallow, moderately deep, well drained with medium runoff and slow permeability. Stony to stony silt loam texture.

GENTLY TO STRONGLY SLOPING PLATEAUS OR TABLELANDS, 5,900 TO 6,300 FEET ELEVATION, 2% TO 15% SLOPES. Shallow to moderately deep, well drained, rapid runoff and very slow permeability. Stony to gravelly silt loam texture.

STRONGLY SLOPING TO MODERATELY STEEP DISSECTED HILLS, 5,600 TO 6,000 FEET ELEVATION, 8% TO 30% SLOPES. Moderately deep to duripan and well drained with slow permeability. Stony to very gravelly loam texture.

STEEP TO VERY STEEP CANYON SIDESLOPES, 5,600 TO 7,200 FEET ELEVATION, 15% TO 75% SLOPES. Soils on south aspects moderately deep, neutral, well drained with moderate permeability. Soils on northerly aspects very deep, neutral, and well drained with slow permeability. Extremely cobbly loam to loamy texture.

As a general rule, soils in the JRW are very coarse but have moderately high productivity. Inherent permeability is mostly slow and primarily moderate to well drained. Many soils in the watershed have duripan, claypan, or shallow depth to bedrock which increases potential for slumping on a localized basis.

Disturbance: Roughly 1.2% of the watershed has visible surface disturbance in the form of Jarbidge town, roads, trails, mining, campgrounds and the Jarbidge landfill (Figure 1.4). Steep terrain within the watershed limits the opportunity for development of homes and industry, though livestock grazing, timber harvest and hardrock mining have occured extensively throughout the JRW. Further development is limited by restrictions imposed by the dominance of public land within the watershed.

In June, 1995, rain falling on snow triggered debris torrents from three of the high gradient tributaries of the Jarbidge River in the upper watershed. Colluvial debris entered the main channel and extenuated the force of rising flood waters. Flood driven debris destroyed or damaged portions of the road that parallels the river channel along the narrow valley bottom. Directly below Fox Creek, a prehistoric debris avalanche forces a short section of the Jarbidge River into an extremely narrow (less than 50 feet) valley bottom. Over 2000 feet of road were rendered unserviceable between Pine Creek Campground and Snowslide trailhead.

Biological Processes and Human Influence: The JRW is currently occupied by two native salmonid fish species. Redband trout *(Oncorhynchus mykiss gairdnerii)* occurs throughout the drainage and, for various reasons, is by far the more abundant. Bull trout (*Salvelinus* *confluentus*) also inhabit the drainage in a much lower density.

The Jarbidge River and East Fork watersheds were selected as priority watersheds for the recovery of bull trout (*Salvelinus confluentus*) during the development of the Inland Native Fish Strategy. Bull trout are represented in the Jarbidge River in both resident and migratory forms; the population in both watersheds is considered depressed. In the Jarbidge River, approximately 19 bull trout have been collected in 13 sampling efforts since 1954, which suggests that bull trout are represented in extremely low numbers. The population of bull trout in the Jarbidge River was estimated at 292 fish in 1994.

There is ample evidence that human activities have influenced and altered terrestrial and aquatic resources in the JRW. Historic uses of the watershed include sheep grazing, mining and milling of gold and silver, timber harvest and the construction and maintainenance of roads for access. These uses and related impacts will be discussed in greater detail in the following chapters.

In this analysis, we attempt to compare and contrast physical attributes of the East Fork and Jarbidge Watersheds. These watersheds appear morphologically similiar at the watershed scale (Figure 1.5).

Recreation/Land Ownership - West Fork of Jarbidge River

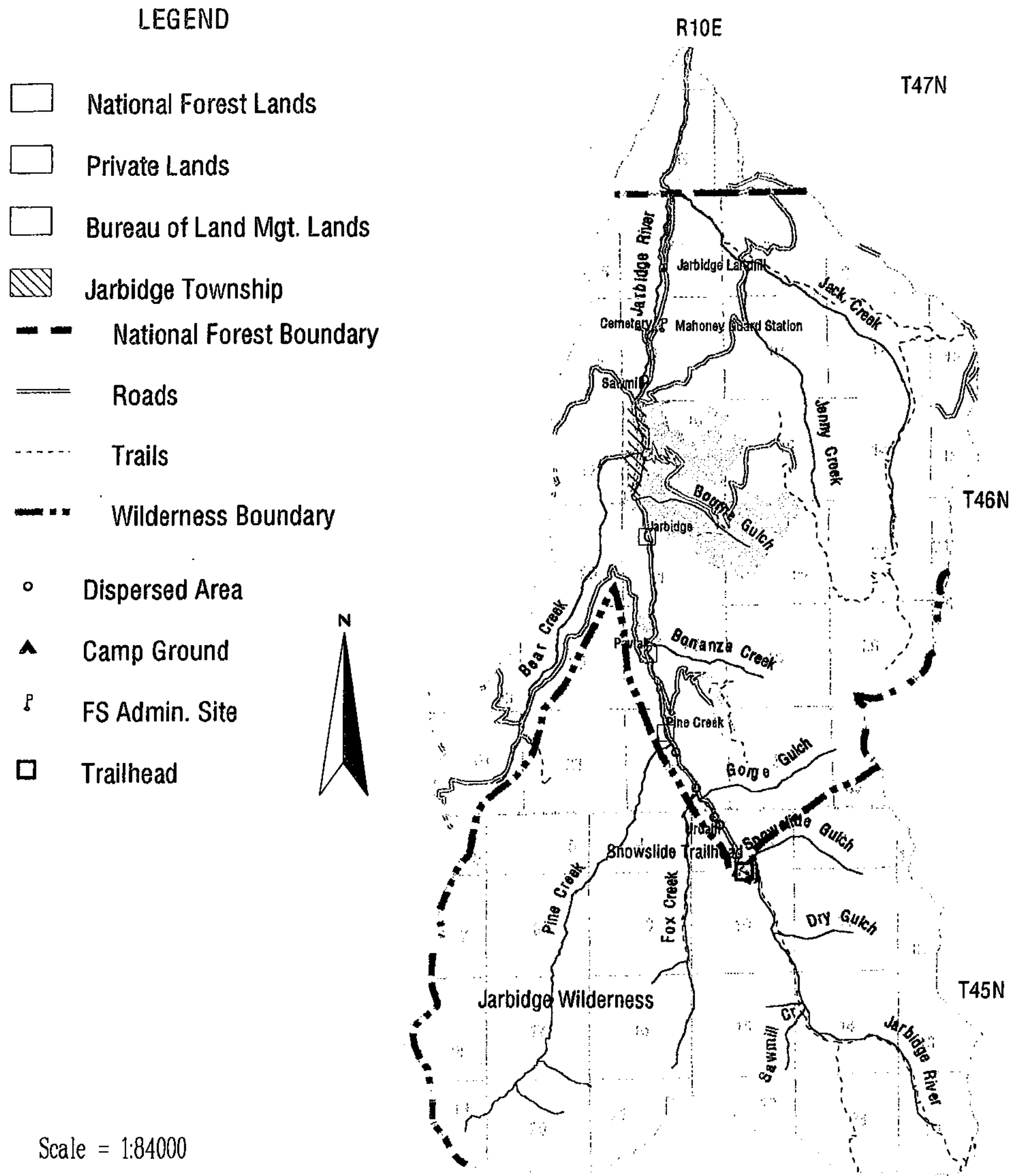

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FIGURE 1.4

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Jarbidge and East Fork Watershed

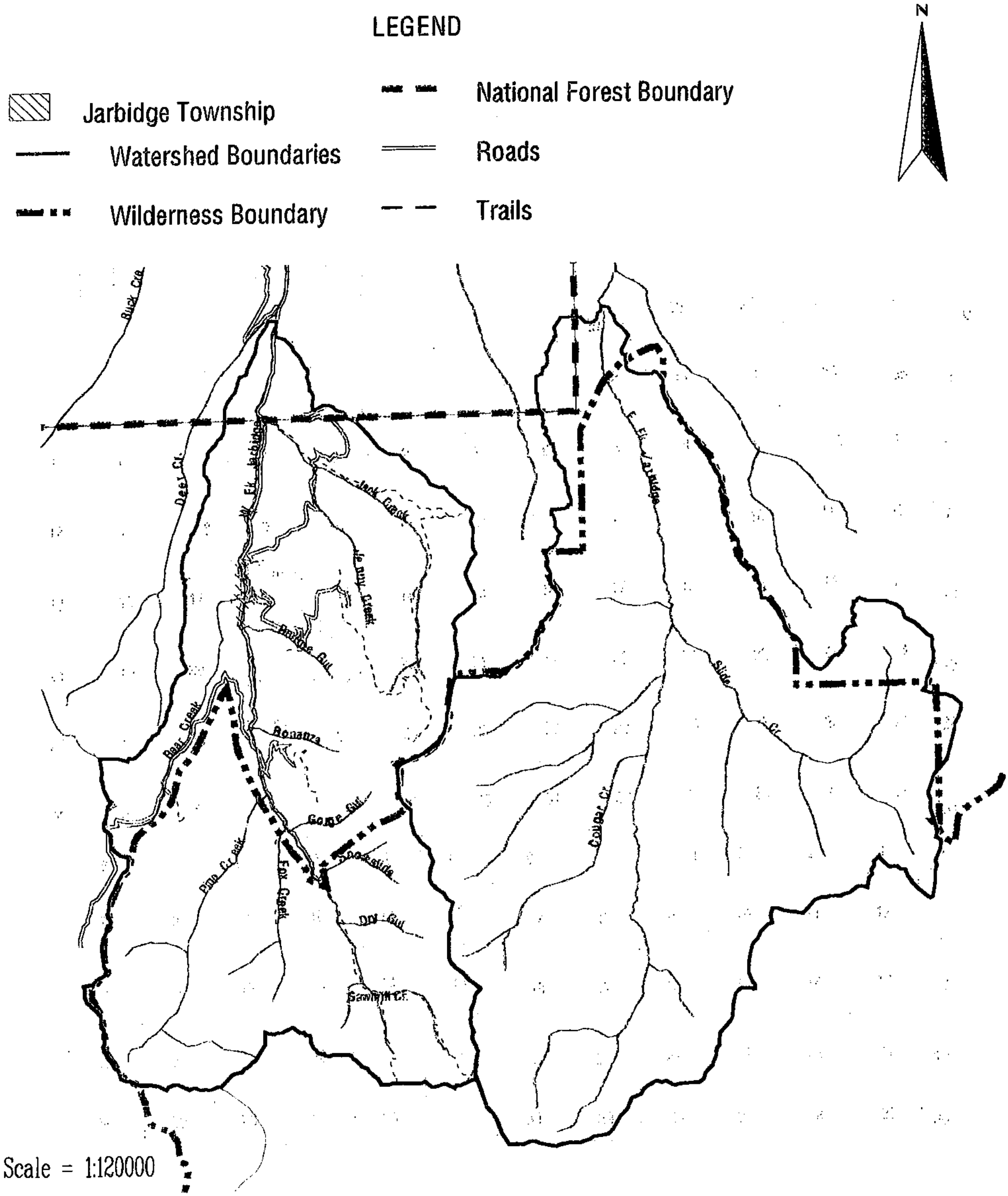

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FIGURE 1.5

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Elevation - West Fork of Jarbidge River

LEGEND

5800 Feet to 7500 Feet Elevation

7500 Feet to Timberline

Above Timberline

Jarbidge Township

National Forest Boundary

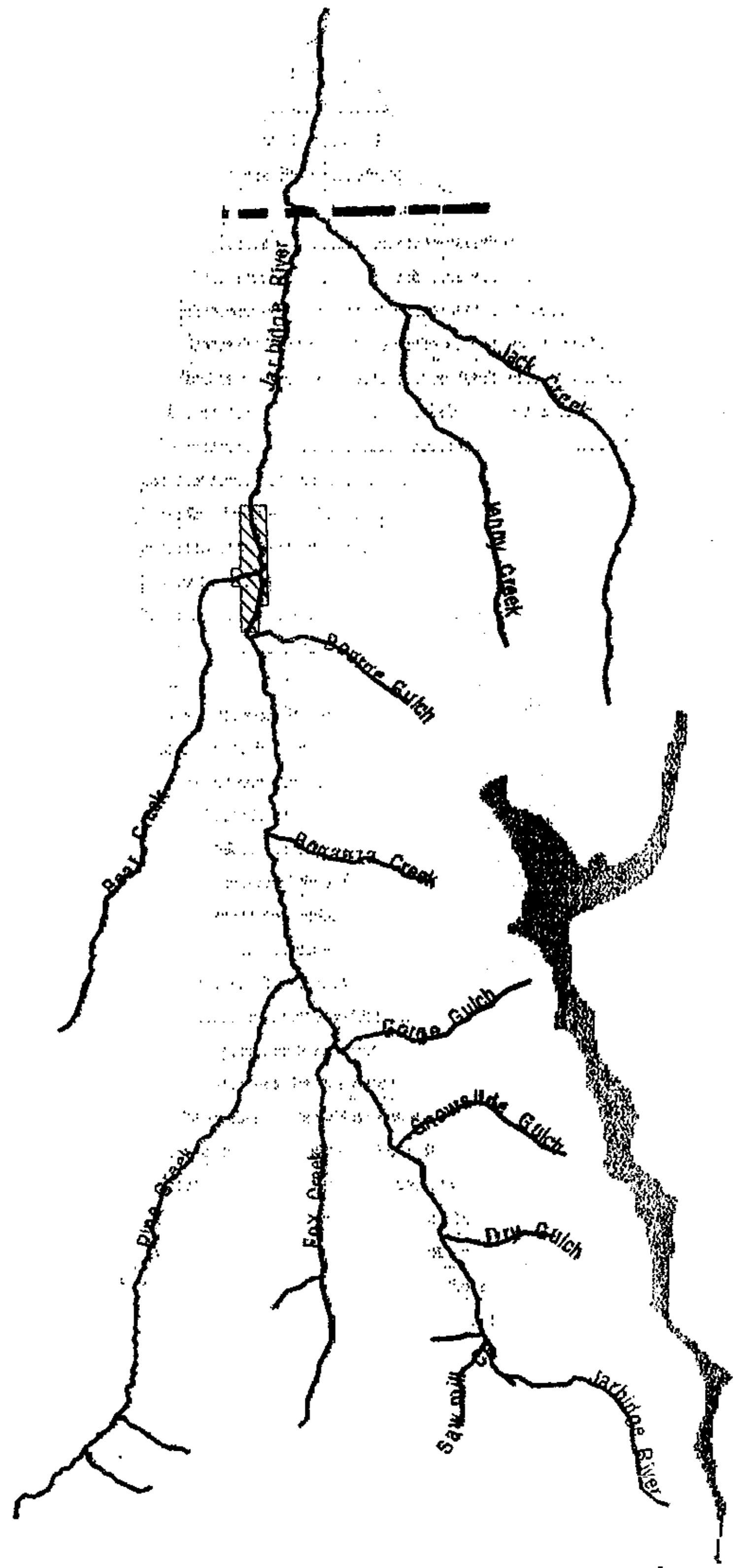

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FIGURE 1.6

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Chapter Two: Identification of Issues and Key Questions

Identification of issues is vital to watershed analysis. The JRW analysis incorporates issues identified through three differenct venues: 1) Those identified during NEPA and public scoping for the proposal to rebuild flood damaged road in the watershed; 2) Public scoping specifically asking for input to the JRW analysis; 3) Line Officer and Specialist input.

The following represents a synthesis of issues identified during public scoping and those identified by Line Officers and Staff Specialists:

A. What effects do management activities have on the characteristics and processes of the JRW?

B. What effects do/have management activities in the JRW had on fish habitat and bull trout populations in the Jarbidge River?

C. What effects do/have management activities in the JRW had on recreation opportunities in the watershed?

D. What effects do/have management activities in the JRW had on the local economy of the town of Jarbidge?

Response to public scoping specific to the JRW analysis was limited. This limited response identified concern with the effect of management activities, both past and present, on local bull trout and red-band trout habitat.

KEY QUESTIONS This analysis does not focus on a single project or activity proposal. It provides a base for future analysis of proposed activities or projects in the watershed through identification of recommendations and/or management activity guidelines. Recommendations and/or management activity guidelines are identified by addressing key questions which incorporate the issues identified.

The issues identified fall within two broad areas: 1) ecosystem health/sustainable use, and; 2) management opportunities (goods, services, and restoration). From this synthesis, two key questions have been identified.

A. How do the conditions of natural resources and human activities over time relate to goals and standards for ecosystem health and sustainable use?

B. What are the priority options for management opportunities (goods, services, and restoration) and potential trade-offs, and consequences of management actions or inactions?

Chapter Three: Description of Current Conditions

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THE RIVER

Stream Order: The Jarbidge River becomes a third order stream below Pine Creek at River Mile (RM) 15.3, and remains a 3rd order stream until the confluence with the East Fork. The Jarbidge River below the confluence with the East Fork is a 4th-order river.

Hydrologic Regime: Flow data for the Jarbidge River are lacking. With limitations, we can use flow data from a gaging station on the East Fork for comparative analysis. Annual peak flows correspond with spring snow melt and occur in May and June. Peak flows may be over 22 times higher than low flows in any given year. Low flow generally occurs from November through January, and may be lower than 4 cfs. Bankfull discharge at the Forest Boundary at RM 4 is estimated at 88 cfs.

Headwater Morphology: We view the steep valley slopes in the upper watershed as a ***source area*** for debris and sediment that flows in to the Jarbidge River. The ***source area*** of the Jarbidge River Canyon is dominated by steep gradient colluvial valleys, where eroding rock and soil accumulate. Dry, Snowslide, Gorge and Bonanza Gulches exhibit a defined stream channel heading in unchanneled colluvial "hollows", grading into channeled colluvial valleys. The ***source*** area gulches are transport limited, such that colluvium accumulates in and along the channel for extended periods. Periodic climatological events, such as the rain on snow event of 1995, flushes some or all accumulated colluvium in a down-valley debris torrent, which typically inundates short ***transport*** sections of the channel as described below.

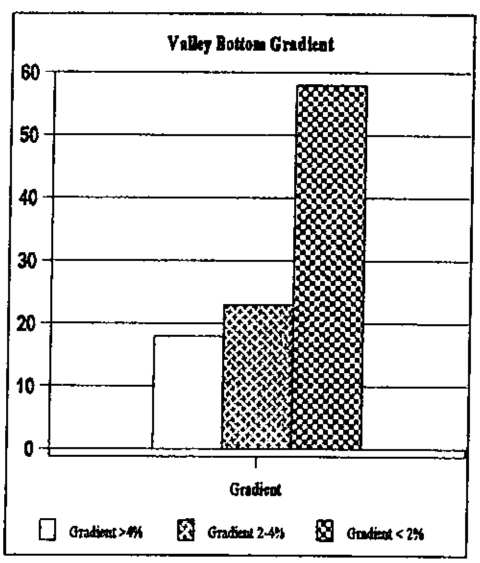


Figure 3.1. Valley Bottom Slope of the Jarbidge River from the headwaters to the confluence with the East Fork.

Valley Bottom Morphology: The Jarbidge River Valley is dominated by low and moderate gradients (Figure 3.1). Eighty-one percent of the Jarbidge River valley has a mean valley bottom slope less than 4%. The valley bottom is extremely narrow, ranging in valley bottom width from 43 feet (the width of the river channel) to approximately 500 feet at the widest point. Review of aerial photographs and limited field verification indicates that only 26% of the Jarbidge River Valley exceeds 250 feet in width. The widest portion of the river valley extends from roughly ½ mile north of the Jarbidge Landfill to south of the town of Jarbidge.

In the upper watershed, debris-colluvial and alluvial fan landforms are common in the valley bottom and contribute to the narrow width. Alluvial fans are found at the mouth of each of the gulches draining the west side of the Jarbidge Mountains.

Channel Morphology: The channel of the Jarbidge River can be characterized as ***source***, ***transport*** or ***response*** based on channel gradient and channel confinement within the valley bottom (see Overton et al, 95). This model seems to fit the Jarbidge River in concept with minor variations in gradient and function at the reach level. From the headwater tributaries downstream to Pine Creek, the Jarbidge River has a mean valley bottom (VB) slope ranging from 7.5 to 4.5%. This channel functions as a ***transport*** channel, moving sediment provided by the ***source areas*** of the surrounding hillslopes and gullied side channels. Even at the these gradients, this and other sections of the river can be considered *transport limited,* in that the rate of large material entering the channel exceeds the ability of the river to distributer this material downstream. The river channel downstream from Snowslide, Dry and Gorge gulches is dominated by angular colluvium, originating as debris torrents from these side drainages.

The Jarbidge River channel from Pine Creek to Bourne Gulch, a 2.3 mile section ranging in VB slope from 3.14 to 2.68 may also be characterized as a ***transport*** channel, though areas of rapid aggregation by colluvial and alluvial material are represented in at least four sites. Deposition of cobble sized in stream and lateral bars appears directly related to influxes of debris from the steep hillslopes adjacent to the river. Downstream from a rockslide at RM 13.4, for example, 53% of the bank substrate sampled (N=50) exhibited rough, angular edges and surfaces, which is not characteristic of alluvial material. In addition, a large influx of debris from Bonanza Gulch occurred during the 1995 flood event. Montgomery and Buffington (draft 1993) observed that in debris-flow prone areas, the debris generally stops at the first down-channel area where the gradient is less than 7 %. Debris from Snowslide, Gorge and Bonanza Gulches enters the channel of the Jarbidge River where channel gradients are typically less than 5%. This suggests that river bed and valley bottom morphology in the *source area* may be dominated by angular colluvium.

Portions of the river from Bourne Gulch to the East Fork may be characterized as ***response*** channels, in that they respond to influxes of sediment and debris from higher gradient sections. One of the common responses that we identify in lower gradient channels is a gradual widening of the meander belt width where the width of the valley bottom will allow. This appears to be the case in the vicinity of Mahoney Guard Station at RM 11.2 and near the confluence of Deer Creek at RM 8.3. In these areas, we feel C type channels existed in the past and that beaver were an important element of the hydrologic regime. Roughly 15% of the river channel from Bourne Gulch (RM 13) to the confluence can be considered a response channel, where as 85% of the river from Bourne Gulch to the confluence is considered a transport channel under this model. These sections are highly confined within the narrow Jarbidge River canyon.

Watershed analysis has identified 7 reaches from the confluence of the East Fork to the headwater tributaries based on variations in valley bottom gradient (see Figure 3.2).

Reach 1, though low in gradient, is highly confined within the lower Jarbidge River canyon. Reach 1 has a higher incidence of in-channel boulder and bedrock than upstream reaches. Reach 1 is low in sinuosity, estimated at roughly 1.04. This reach is highly confined within the valley bottom, is considered an F type channel, and functions as a transport channel as described above.

Reach 2 is also confined within the Jarbidge River Canyon, but flows a wider valley bottom near the confluence with Deer Creek and downstream from the Jarbidge Landfill. Here the river exhibits slightly higher sinuosity (estimated at 1.25) and meander belt width, and is considered a B or C type stream. Deposition of alluvial debris is evident in few areas in Reach 2.

Figure 3.2

Reach	From	To	VB Slope	Channel Type	Channel Type	Wetted Width
1	RM 0-Confluence of East Fork	RM 4-Idaho State Line	1.63	Transport	Rosgen F	?
2	RM 4-Idaho State Line	RM 11-Jarbidge Landfill	1.72	Transport/ Response	Rosgen F2/C3	7.14m
3	RM 11-Jarbidge Landfill	RM 12 North end of Jarbidge Town	2.18	Response	Rosgen B3, D3	5.64m
4	RM 12 North end of Jarbidge Town	RM 13 South end of Jarbidge Town	3.14	Transport	Rosgen B3, G3	5.1m
5	RM 13 South end of Jarbidge Town	RM 15.3 Pine Creek	2.68	Transport	Rosgen B3	6.46m
6	RM 15.3 Pine Creek CG	RM 16.8 Snowslide Gulch	4.61	Transport	Rosgen A3, B3	4.29m
7	RM 16.8 Snowslide	RM 18.75	7.3	Transport	Rosgen A3, B3	2.77m

Reach 3 also exhibits a slightly higher sinuosity associated with a widening of the valley bottom. Reach 3 is strongly influenced by past and present human activities and developments. Here are found B and D (braided) stream channels, though aerial photo analysis suggests that C type channels may have been the dominant configuration in the presettlement and immediate post settlement past. Deposition of alluvial material is evident throughout most of this reach.

Reach 4 runs through the town of Jarbidge. This section is highly modified by past and ongoing human activities and developments. Channelization for flood control has occurred in this reach. Though classified as a B type channel, this reach functions as a G (Gully) during high water.

Reach 5 The valley bottom in Reach 5 averages roughly 250 feet wide. Sinuosity in this section is quite low at 1.07.. There are 4 bridges in this 2.3 mile reach, suggesting that there may be a correlation between the bridges and low sinuosity. Jarbidge, Pavlac, Bluster and Pine Creek Campgrounds are in Reach 5; each of these campgrounds fall within the meander belt width of the Jarbidge River.

Reach 6 and **Reach 7** Evaluation of aerial photos indicates the meander belt width of the Jarbidge River in Reach 6 (specifically Fox Creek to Pine Creek) varied between 100 and 200 feet. Associated with this belt width was a channel wave length of 300-400 feet and a radius of curvature of roughly 100 ft.

Gullies (G channel types) developed in reaches 6 and 7 during the 1995 flood. In Reach 7, the gully formed downstream from Snowslide Gulch, where a large debris torrent inundated the channel with colluvium. In Reach 6, the gully is associated with a large debris avalanche that constricts the river to it's narrowest point at 43 feet. The constriction in the channel is thought to have increased the velocity of flood waters. Coupled with a sudden influx of colluvium from source area side channels, the river formed a gully where the Jarbidge Canyon Road was prior to the flood. The combined length of gullied channel sections is approximately 1500 feet (1.5% of the river).

Substrate: The dominate substrate size in the Jarbidge River is about 100 mm (cobble), suggesting that water velocities associated with the 1.5 year event are sufficient to entrain the sub cobble size material but not high enough to completely displace the cobble and larger substrate. Much of the colluvium entering the Jarbidge River from the *source area* gulches is cobble size and larger. The river appears to be sediment-poor in gravel and smaller sized material within the active channel in those areas sampled. Fine sands and gravels were evident at or above bankfull, but uncommon within the wetted perimeter in October of 1996. Material smaller than cobbles is deposited outside the active channel during above-bankfull flows.

Recent pebble counts in Fox and Pine Creeks suggest an overall smaller substrate size in these tributaries. These counts indicate a bimodal distribution of 10-16mm and 100+ mm for Pine Creek and an even distribution of size classes from 400-500 mm in Fox Creek.

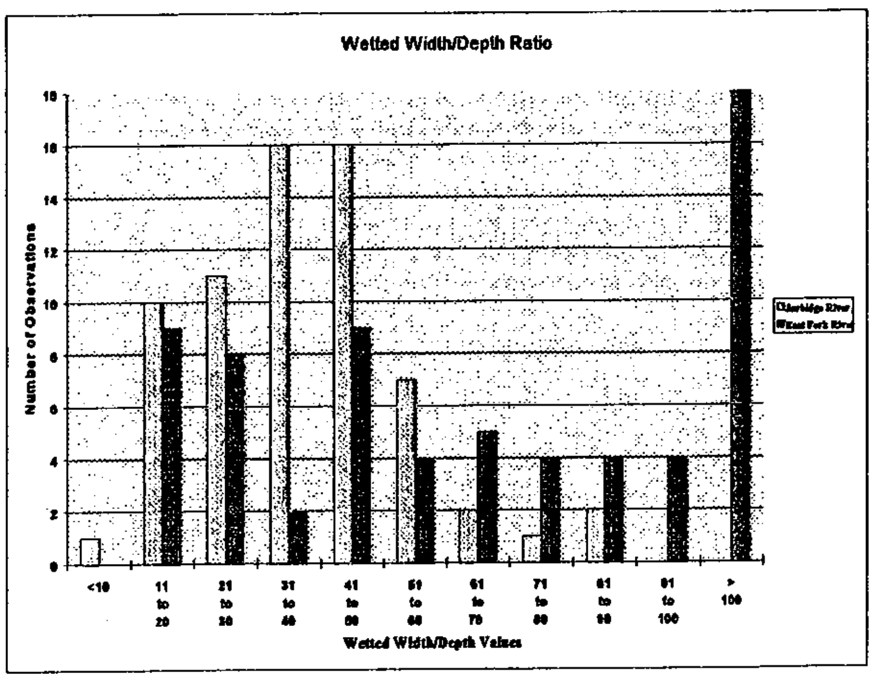


Figure 3.3. Wetted width/depth ratios of the Jarbidge and East Fork Rivers.

Strong sculpin populations throughout the drainage below Snowslide indicate embeddedness is low, as sculpin are benthic feeders and rely on cobble-boulder substrate for cover.

Width/Depth Ratio: Figure 3.3 illustrates observed wetted width/depth ratios of the Jarbidge and East Fork Rivers based on survey data collected in 1985 and 1993 (resp.) and stratified by elevation. Width/depth ratios below 20 represent only 14% of the observed values in the East Fork watershed, which has had comparatively little recent modification by humans and serves as our reference watershed. Of 65 wetted width/depth samples taken during the 1993 habitat survey in the East Fork, *none were less than 10,* as recommended as *Riparian Management Objectives* under INFISH.

Pools and Large Wood: Available for analysis are GAWS habitat surveys for the Jarbidge River (1985) and the East Fork (1993), each using a series of non random transects perpendicular to the direction of flow and measuring the portion of the transect in pool or riffle. These transects further estimated *pool quality* as one of 5 categories and identified the feature(s) influencing pool formation. We feel pool quality categories 1-3 are equivalent in function to *main channel pools* as described in INFISH (1995), and use the term *quality pools* as a synonym for *main channel pools.* Using these data, it is extremely difficult (if not impossible) to develop a credible evaluation of pool number and quality within the parameters of *pools per mile.* We do not feel that converting GAWS habitat transect data to *Pools Per Mile* is scientifically sound.

Also available for analysis are aquatic sampling transects conducted in conjunction with the GAWS habitat surveys. These sampled a measured length of river at each of the stations where habitat data were collected. In 1985, the pool:riffle ratio was estimated as was the percentage of area that was considered pools in category 1-3. The 1985 estimates became extremely questionable when we attempted to determine the number of quality pools or pool size in either area or linear distance. In 1993 on the East Fork, these parameters were actually measured as linear distance upstream, thus allowing Johnson (pers. comm. 97) to establish a credible *pools per mile* estimate for the East Fork. Johnson estimates that the East Fork River has 32.5 quality pools per mile from the Forest Boundary to the headwaters.

Using the mean quality pool length measured in the 1993 East Fork aquatic survey and the length of sample in quality pool estimated during the 1985 survey of the Jarbidge River, we estimate 16 quality pools per mile for the Jarbidge River.

Watershed	Total Pools per Sample	Quality Pools per Sample	% QP's with Large Wood	% QP's in Wilderness	% QP's in Wilderness w/LWD
Jarbidge	1.09	.27	22%	35%	50%
East Fork	2.01	.25	12.5%	NA	NA

Figure 3.7. Comparison of pool data for Jarbidge and East Fork Rivers.

We can compare the Jarbidge and East Fork River watersheds in reference to pool number and quality in a slightly context. Figure 3.7 compares pool related attributes between the two watersheds developed from GAWS habitat data.

Johnson compared stream habitat characteristics in preparation of *The Status of Bull Trout in Nevada* (Johnson and Weller, 94). This analysis documented a significant difference between the number of pools between the Jarbidge and East Fork Rivers, resulting in a lower Habitat Condition Index (HCI) for the Jarbidge River. Data from GAWS surveys displayed in Figure 3.7 supports this, in that the East Fork has nearly 2 times the number of pools per sample as the Jarbidge River. Note, however, the number of *quality pools* sampled in the Jarbidge River exceeds the number sampled in the East Fork River. This seems to conflict with the estimate of 16 quality pools per mile in the Jarbidge River.

Also significant here is the percentage of the quality pools in the Jarbidge River that occur within the wilderness. Thirty-five percent of the quality pools surveyed in the Jarbidge River fall within the upper 10% of the river. One half of the quality pools in the wilderness are formed by large wood, where as only 7% of the quality pools below the wilderness were formed by large wood.

Quality pools are probably the last element of fish habitat to redevelop once lost (Kapesser, quoted in Cross and Everest 1995). Channel armoring (settling and compaction of the substrate) reduces vulnerability of the stream bed to scouring action, so that flood events of greater magnitude are required to destabilize and scour the stream bed and create new pools. Quality pools developed within 6 years following stream bed destabilization from channelizing the West Fork Jarbidge in 1979. Rosgen (96) observes that B-type channels typically produce infrequent pools, occurring primarily at bends or constrictions in the channel. The combination of B channel types and slow recovery of quality pools following disturbance suggest that channel altering flood events in the Jarbidge River have the potential to dramatically alter fish habitat for extended periods..

Large wood (LW) is an extremely important component of in-stream and floodplain habitat. Large wood provides food, cover, substrate, bank and floodplain stability (Maser and Sedell, 94). Large wood is extremely important for pool formation in low order river and streams. Review of settlement history suggests that much large wood was removed from the banks of the Jarbidge by the early miners and settlers; the morphology of the river channel today probably reflects the alteration of stream side gallery forests early in this century. The Jarbidge River corridor has served human use in the JRW with an unknown amount of firewood, particularly where the adjacent road makes collection easy(er). In addition, where the stream is accessible by road, in-stream large wood is actively removed for flood control. Prior to high water in 1996, large wood was removed from the stream channel 50 yards from the south end of the Jarbidge Canyon Road, 2.5 miles from the town of Jarbidge.

The loss of large wood is is reflected in recent survey data that document a higher density of large wood above Snowslide Gulch, which was not accessible by vehicle prior to the 1995 flood, than below Snowslide Gulch, which was accessible. Large wood above Snowslide meets (and exceeds) the Riparian Management Objective (RMO) for this habitat component; the reach below

Snowslide falls far short at only 25% of the RMO for large wood.

Water Quality: The Nevada Department of Environmental Protection (NDEP) maintains water quality sampling stations along the Jarbidge and East Fork Rivers. Available for analysis are data from three stations, E-7, directly above the town of Jarbidge, E-6, directly below the town of Jarbidge, and E 11 above the town of Murphy Hot Springs on the East Fork. These data have been collected sporadically since 1966; on hand at the time of this writing are data from 1966 through 1996. In addition to stations E-6 and E-7, periodic sampling of some water quality attributes has been conducted on a project specific basis. To our knowledge, effluent from the Pavlak adit and the Greyrock Shaft (both draining into the Jarbidge river) has only been tested 1 time. It is unlikely that the water flowing from the Norman Mine in the headwaters has been tested.

pH Comparison of the mean pH values from above (E-7, pH 7.39) and below (E-6, pH 7.21) the town of Jarbidge suggest the river below town may be slightly more acidic. Both *mean values* fall within the 6.5 to 9.0 range determined by the U.S. Environmental Protection Agency to acceptable to aquatic life forms. Recent measured pH values at these stations range from a single 6.0 value in 1972 to 8.3 in 1967.

Effluent from the Pavlak adit was tested in 1996. Discharge from the Pavlak adit was measured at 42 G.P.M., pH 8.18. Flow from the Elkoro adit was tested for some heavy metals in 1977 revealing a pH of 6.27.

Heavy Metals: Measurable **Arsenic** has been detected in the Jarbidge and East Fork Rivers. Detectable levels in the Jarbidge River have only been found in effluent from the Greyrock shaft (1977) and downstream at station E7, below the town of Jarbidge. Thurston et al (79) suggest that levels detected (0.05ppm) have the potential to be chronically toxic to salmonids. **Copper** levels are similar in the East Fork and Jarbidge Rivers. Though unlikely to harm fish, intermittent spike concentrations may pose chronic or lethal conditions for phytoplankton and some invertebrates.

Soluble **Iron** levels measured below the town of Jarbidge consistently exceed the 1986 EPA Domestic Water standard of 300 micrograms per liter (ug/L) by 30%, whereas iron levels above town and in the East Fork River are well below this standard. Thurston et al (79) found that soluble iron levels *at* 300 ug/L may exceed acceptable limits for aquatic invertebrates. The 1979 fish habitat survey conducted in the reach through town noted " ... Notably few invertebrates ..." (emphasis theirs) downstream from the Elkoro Mill site (and Grey Rock Shaft). Ramsey (pers. comm. 97) indicated that iron concentrations at the recorded levels may be affecting aquatic life in the Jarbidge River.

Temperature: Numerous authors have discussed temperature requirements for salmonids (Meehan, 91. Behnke, 92. Li, 94). Bull trout appear to prefer water with cold and constant temperatures (Pratt, 92). In the Jarbidge River system, bull trout appear to be associated with water that averages 10 degrees C and less (Gary Johnson, pers. comm. 96). Adult bull trout have not been found in the lower Jarbidge system when water temperatures exceed 14 degrees C (Zoellick et al, 95). The current distribution of bull trout in the Jarbidge River appears to be determined by seasonal fluctuations in water temperature (Warren and Partridge, 93; Zoellick et al, 95). As water temperatures increase to unfavorable levels in July and August, bull trout are forced upstream and into tributaries which exhibit lower temperatures. The population(s) of bull trout in the Jarbidge and East Fork River watersheds may be limited by the distribution of cold water during key periods.

Available for analysis are stream temperature data collected at various times between 1954 and 1997. This data set is a compilation of at least 10 sources, and as such contains a high degree of "noise". We have attempted to reduce noise by selectively weeding out grey data and by stratifying these data by reach, stream mile, date and time collected. To offset variations in sampling methods and instruments, we used the mean values in each river mile for July and August, the two months that exhibit the highest water temperatures in the Jarbidge River. Small sample size and non-random sampling contribute to the variation in values, particularly in the middle portions of the river. Only two samples, for example, taken during the same survey, are

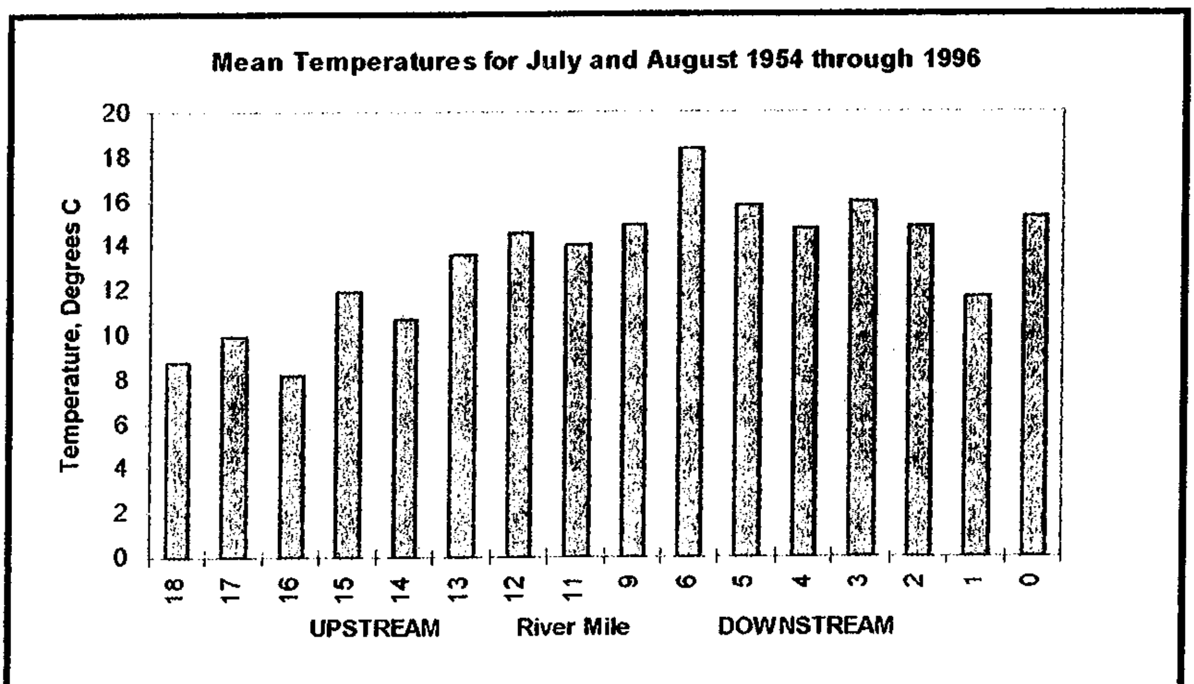


Figure 3.4 Mean water temperature during July and August.

available for RM 6. We recognize the limitations of these data.

Figure 3.4 shows a general downstream warming trend from the headwaters at River Mile (RM) 19 to RM 0 at the confluence with the East Fork. Figure 3.4 also illustrates that most of the

Jarbidge River remains tolerable to aquatic organisms throughout the warmest part of the year *in general.* Review of the data set and knowledge of local conditions reveals that the lower 60% of the river (from RM 12 down) may sustain afternoon temperatures over 18 degrees C from mid-July through mid-August. Furthermore, water temperatures in the lower river may fluctuate as much as 9 degrees within a 12 hour period.

Several factors influence late summer stream temperatures in the East Fork and Jarbidge River watersheds. Principle among these is the north and south alignment of these watersheds resulting in the lack of effective shade during the middle part of the day. Individual trees and riparian stands are an important element, but not to the extent we expect from rivers with an east-west alignment. (Brown, 80).

Also important in the temperature equation is the morphology of the river channel. As noted in Figure 3.3, both river channels exhibit high width to depth ratios. Narrow river channels are more likely to be effectively shaded by riparian vegetation. As channels become wider, the height of riparian vegetation must increase to accomplish the same degree of shading. Stable stream banks also promote stream shading, in that stable stream banks can develop late seral vegetation, specifically cottonwoods and coniferous trees, which can shadow the river channel. Developing stream side communities as would exist following stream bank disturbance typically exhibit early seral vegetation, which is less effective in stream side shading. In general, disturbance to stream banks, natural or man caused, does not promote reduced water temperatures.

We have a limited opportunity to compare mean stream temperatures of the Jarbidge River with those of the East Fork. Available for analysis is a single data set from the 1993 stream survey and data from an NDEP storet station at mile 2.7 on the East Fork. With the exception of data from mile 2.7,

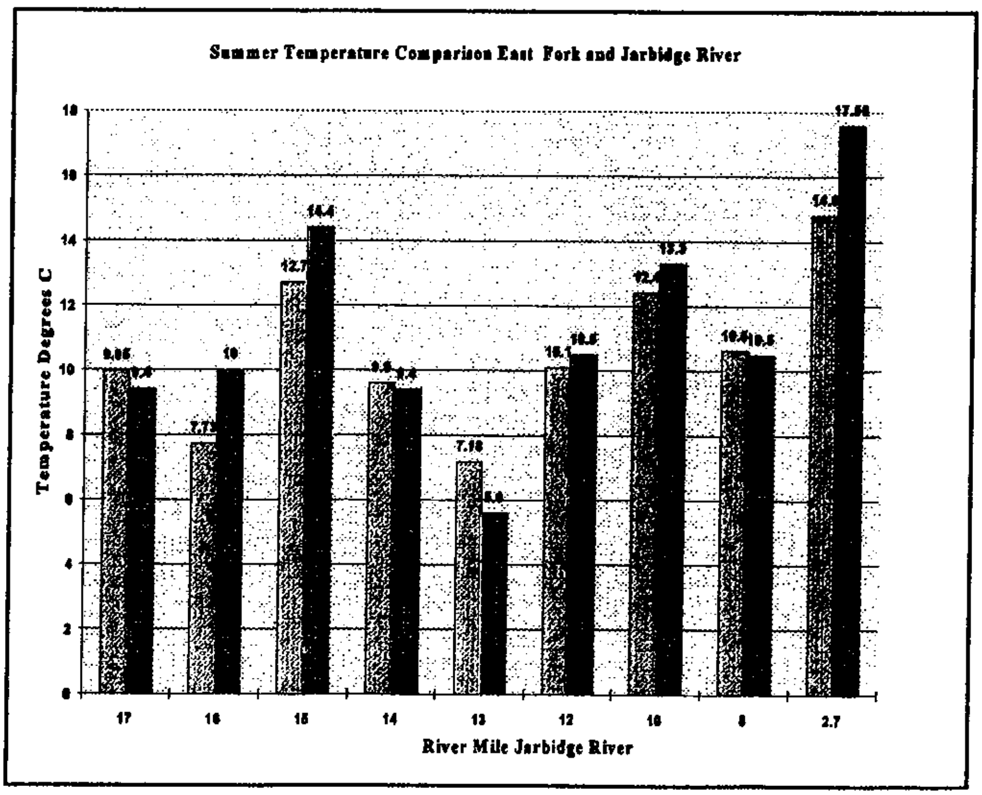


Figure 3.5. Comparison of summer water temperatures between the Jarbidge and East Fork Rivers.

temperatures on the Jarbidge River appear to parallel those of the East Fork. Temperatures at mile 2.7, however, indicate that the East Fork is significantly warmer than the Jarbidge River when compared in this fashion.

Other Water Quality Concerns: Disposal methods in this remote area are still limited, and disposal protocols for ore-processing chemicals were not likely very rigorous even up to mid-century (Marks, pers comm, 96). A Class III municipal landfill is still-active on the 100-year floodplain in Reach 3. This landfill dates from the 1940's and possibly earlier. Items neither authorized nor appropriate for disposal in a Class III landfill are observed periodically in the landfill, including car batteries and empty 55-gallon drum, neither of which are authorized for a Class III landfill. The surface of the landfill is on the 7-foot terrace; refuse pits are within 45 feet of the active channel. Though the hyporrheic zone of the river adjacent to the municipal landfill is suspected of being contaminated via groundwater, no water quality testing has been done at this site to the knowledge of the Analysis Team.

UPLANDS

Soils: Soils are shallow and residual, derived from parent material, colluvium and alluvium. Valley side slopes tend to be "weathering-limited" (Montgomery and Buffington, draft 93), in that the rate of soil transport down slope tends to be faster than the weathering processes creating that soil. In arid environments, down slope movement consists of larger particles than in more humid environments.

Vegetation: Vegetation was mapped utilizing vegetation cover-types developed by Utah State University for the GAP analysis project. Ten separate cover-types were mapped in the JRW. Acreage of each type was determined as a percent occurrence within the total watershed acreage. Following is a description of cover-types found in the JRW along with the percent occurrence for each.

ALPINE - High elevation tundra vegetation, including forbs, sedges, grasses and shrubs. Usually occurs above 10,000 feet within the JRW.

BARREN - Barren soil or rock with less than 5 percent total vegetative cover. Can occur throughout the JRW.

SNOW - These are high elevation snowdrifts which still occurred when the satellite image was taken. In the JRW, this occurs in the Jack Creek crater and is associated with permanently frozen sub-soil and remains in place throughout the year.

GB SUBALPINE PINE - Conifer woodland principally dominated by limber and whitebark pine. Typically occurs between 8000 and 10000 feet elevation within the JRW. Canopy cover ranges from 30-60%.

SUBALPINE FIR - Conifer forest principally dominated by sub-alpine fir at canopies greater than 60%. This type is found only in the Bull Run, Independence and Jarbidge mountains in Nevada.

ASPEN - Deciduous forest principally dominated by quaking aspen at canopies from 30% and greater. Found throughout the JRW, occurring at higher elevations and on cooler aspects. Also found in association with riparian areas along streams within the watershed which are too small for delineation as individual cover-types.

MTN. SAGEBRUSH - Mountain shrubland dominated or co-dominated by mountain big sagebrush, low sagebrush, and associated with mountain shrubs, grasses and forbs. Widespread at elevations mostly from 6500 - 10000 feet.

MTN. MAHOGANY - Woodland principally dominated by mountain mahogany in canopies less than 30%. Typically located on steep, rocky, and dry slopes.

MTN. SHRUB - Deciduous shrub land principally dominated by bitterbrush, serviceberry, snowberry and current. Typically wide-spread and many time associated in small patches with other cover-types.

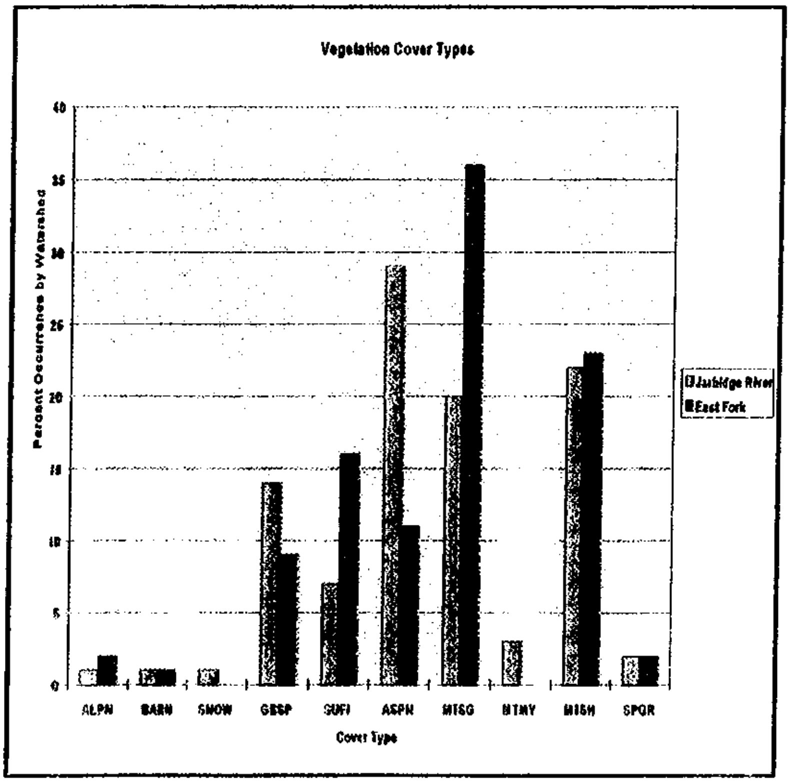


Figure 3.7. Vegetation cover types in the Jarbidge and East Fork Watersheds based on GAP analysis. Comparison of cover types is determined by percent occurrence within the paired watersheds.

SAGE/PERENNIAL GRASS - Codominant sagebrush shrub land and perennial grassland. Codominance is defined by either shrub or grass occurring at canopies at least 25% of the other. A wide-spread part of the sagebrush steppe, it can also occur at mid-elevations between sagebrush and mountain sagebrush types.
Vegetation was mapped in the East Fork Jarbidge River watershed as a basis for comparison. The following figure illustrates the relationship based on percent occurrence for each cover-type.

Although significant amounts of woody material were harvested in the JRW at the turn of the century, it now has a higher percent occurrence of tree dominated cover-types. Aspen represents the largest difference in percent occurrence of cover-types between the two watersheds. As aspen is quite often a seral expression of coniferous ecological types, the relatively large acreage of aspen cover-type in the JRW could be further indication that it is a recovering watershed. Aspen associated with stream side riparian systems would not be delineated by satellite imagery. We don't feel the percent occurrence, based on the total aspen cover-type acreage in both watersheds, would be significantly changed with delineation of those sites.

Riparian Vegetation: In constrained reaches, riparian plant communities form a narrow ecotone with up slope communities and associations. In contrast, plant communities in unconstrained reaches are complex, heterogenous patches of differing successional stages including tall forbs, grass and sedges, juniper, cottonwood and subalpine fir.

Conifers and aspens dominate the woody riparian communities in the upper valley, shifting to communities exhibiting a high incidence of cottonwood from mid-valley downstream to approximately RM 4.7. Below this point, the narrow, constrained river valley apparently excludes cottonwood development .

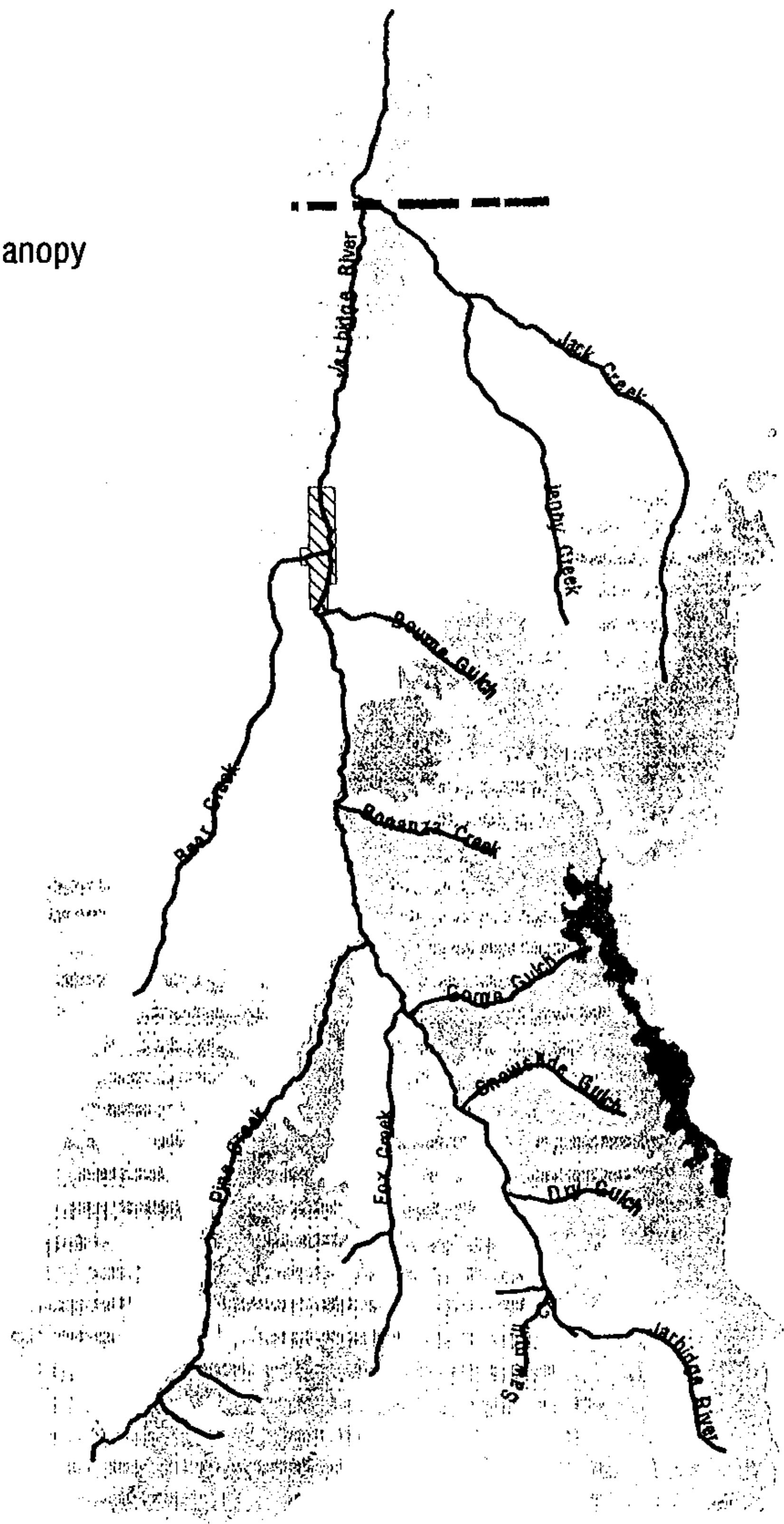
Cottonwoods are the primary source of large wood inputs to the river from RM 15.3 (Pine Creek) to roughly RM 11, near the landfill, and near the confluence of Deer Creek at RM 8.5. Cottonwood can be found up to Sawmill Creek. Above Pine Creek, conifers and aspen tend to dominate the tree species within the RHCA.

MACROS: Woody material also serves as a food source for macroinvertebrates, particularly in a nutrient-poor system. Macroinvertebrate samples from the East Fork Jarbidge River produced only .4g/m2, whereas the West Fork Jarbidge River produced 1.4g/m2, more than 3 times the productivity of the East Fork. This level of productivity is still low and can only support a moderate fishery. The difference in productivity between the 2 watersheds could be due to a greater prevalence of LWD in the West Fork relative to the East Fork (Johnson, pers. comm. 96). Macroinvertebrate quantities are probably lowest in the spring in this system due to substrate movement during high flows.

Vegetation - West Fork of Jarbidge River

LEGEND

- Aspen
- Great Basin Subalpine Pine
- Mountain Mahogany < 30% Canopy
- Sub Alpine Fir > 60% Canopy
- Mountain Sagebrush
- Mountain Shrub
- Sagebrush/Perennial Grass
- Alpine
- Rock/Talus
- Snow
- Jarbidge Township
- National Forest Boundary



Scale = 1:84000

B. Whalen

05/06/97

FIGURE 3.8

This GIS product was compiled from various sources and may be corrected, updated, modified, or replaced at any time. For more information contact: Northeast Nevada Ecosystem Elko, Nevada (702)738-5171

Biological Processes and Human Influence: Our review of the Jarbidge River Watershed strongly suggests that human activities have altered the morphology of the Jarbidge River. The Jarbidge River Watershed is far from a pristine wilderness. The mechanisms for human influenced broad scale change certainly exist, and it is likely that the present condition of the river reflects watershed alteration to some degree. In each of the following sections, we attempt to place system attributes within a historical perspective and portray the present condition of the Jarbidge River as a product of the past.

Jarbidge Canyon has a long record of human occupation. Excavation evidence from Deer Creek Cave indicates the canyon was occupied seasonally from about 8,000 B.C. through sometime after A.D. 1150 by archaic groups, and from A.D. 1150 to historic times by the Shoshoni Indians. Deer Creek Cave and other sites within Jarbidge Canyon suggest a heavy reliance on hunting and plant gathering in the area. Game species, including mule deer and big horn sheep were taken in this canyon, and large game drives are thought to have occurred on the upper plateau and neighboring canyons. Diary accounts of Kitty Wilkins, an early area rancher, detail the trapping and slaughter of a large mixed herd of deer and antelope in nearby Dave Creek in October of 1894.

We now recognize that pre-European inhabitants actively manipulated their environment through the use of fire and the control of the population size of key wildlife species. We cannot, however, quantify anthropogenic changes to the landscape prior to recorded history.

Beaver: Though short-lived, the first half of the nineteenth-century marks a point of departure for most of the upland watersheds of the Snake River, including the Owyhee, Bruneau and Jarbidge Rivers. Between 1811 and 1840, most of the beaver were trapped out of the Snake and Salmon River drainages (Murphy and Murphy, 86; Chrittenden, 54; Idaho Historical Society, 73). Peter Skene Ogden of the Hudson Bay Company, on his second Northeastern Nevada expedition from Fort Boise in 1828, trapped the Bruneau, Jarbidge and South Fork of the Owyhee Rivers (Patterson, et al, 69; Cline, 74; James, 81). In addition, John Work of the Hudson Bay Company further carrying out the British "scorched earth policy" trapped the Bruneau (including the Jarbidge) and Owyhee Tributaries in 1831. Other smaller parties trapped in the area over the next 14 years (Patterson et al, 69).

The intent of the "scorched earth policy" was to form a barrier between the Hudson Bay Companies' fur trade along the Pacific Coast and the onslaught of American expansion from the east. Under this policy, beaver were aggressively trapped out of any drainage in which they could be found, leaving little of economical value to entice exploration from the east.

Beaver can strongly influence the hydrologic function of low order stream and rivers, generally associated with water impoundment and floodplain building. The removal of beaver from the system often a direct cause of channel incision through the creation of erosional head cuts or rapid influxes of sediment and debris downstream. Though beaver were active in the upper portions of the watershed within the last 50 years, channels with gradients less than 3%- *response channels*- are optimum for beaver in most situations (Olsen and Hubert, 94). We think that beaver would have been most active in the Jarbidge watershed precisely where they are now most active, that being the low gradient sections of the *response* portions of the river. Beaver persist in the Jarbidge River from RM 6 to RM 11 in spite of current attempt at control, and it is likely that beaver were prevalent in this and other reaches prior to human entry into the Jarbidge Canyon. The Jarbidge River supported higher beaver populations than are currently found, though specific areas of habitation were resource cyclic and dependant on the composition of the riparian community. Beaver impoundments, lodges and side channels occupied a larger proportion and probably dominated the valley bottom from RM 6 through RM 14. Beaver ponds would have provided extensive rearing and wintering habitat for salmonids, influenced the riparian plant community and altered the flow regime of the Jarbidge River.

Why is this significant? Impoundments foster the deposition of fines, predominately sands and silts but also gravel in the spawning size range. Impoundments also increase the retention time of the system, such that nutrients and organics move down the river at a slower rate than in an un-impounded or simplified system. In systems that exhibit low primary productivity such as the Jarbidge River, secondary productivity in the form of macroinvertibrates (fish food) results from the retention of nutrients and the availability and processing of organic material (Vannote et al, 80).

An increase in slow, deep impounded water translates to increased rearing habitat, wintering habitat and macroinvertibrate production. In contrast, beaver impoundments can increase downstream water temperatures and elevate biological oxygen demand (BOD) in the actual impoundment, both of which could negatively influence fish habitat. On the watershed scale, beaver impoundments increase the complexity of riparian habitats, which is beneficial to aquatic systems. Beaver ponds have been shown to be favored overwintering places for resident bull trout (Jacober, 92).

Livestock: Significant grazing occurred in the JRW during the late 1800's and early 1900's. A 1917 Forest Service report indicated that grazing had been known to occur in the watershed as early as 1885. This early grazing (1885-1909) by "tramp" or "rogue" sheep outfits is considered to be extreme by current standards. There is indication in *A Favorable Report on the Proposed Bruneau Addition to Independence National Forest, Nevada* (Wilson 1906) that addition of the Jarbidge River Canyon to the Forest Reserve system was promoted by area ranchers who were distressed at the overgrazed conditions of the land resulting from "tramp" sheep outfits. He also noted that "the new proposed reserve is the newest, best, and largest stretch of summer sheep range in this part of the United States". Formation of a Forest Reserve would eliminate the "tramp" sheep herds as these herders did not own a land base from which to graze. By the same act, competition between resident and "tramp" sheep herds would be reduced or eliminated. In the above report, Forest Ranger Wilson observes:

"It is claimed by some old timers that the water supply is visibly decreasing because of the heavy sheep grazing. This statement is merely quoted for what it is worth "

"... 392,350 sheep using the Bruneau Forest Reserve between June 1 and Sept 30. 5-8 years previous there were less sheep in the country... "

"Carrying capacity is diminishing all the time but has not yet reached that point where it is beyond the power of nature to bring it back to its former condition"

"What few fires there are occur in the fall and are directly attributable to the sheep herders setting out fires in the brush and timber on leaving the range at the end of the season"

With establishment of the Forest Reserve in 1909, the "tramp" sheep herds were eliminated and the first attempts at resource management of the JRW initiated. Early range files indicate that grazing allotment boundaries were delineated beginning in 1910 and subsequently modified several times until 1960. During that same period, two active allotments were defined and the area within the Bear Creek drainage was restricted from livestock grazing as a domestic watershed for the town of Jarbidge. One allotment was established in the upper watershed from a northern boundary close to Pine Creek and running south to the southern boundary of the JRW. It encompassed the entire upper watershed excluding the Bear Creek drainage. The second allotment was in the lower watershed encompassing the area around the Jarbidge townsite and east of the river. It extended up the drainage to the ridge south of Bourne Gulch. Although no apparent formal name was given to the upper watershed allotment, the lower watershed delineation became known as the Jarbidge Local allotment.

In 1909, a permit was issued to graze 20,000 sheep in the upper watershed along with portions of the Bruneau watershed now administered by the Mountain City Ranger District. A 1917 report indicated that approximately 12,000 sheep were in the upper JRW from June 15 to October 15. Although records are incomplete, it would appear this heavy use continued through 1929. A 1922 stocking study indicated that permittees came into the area late and left early because there was not adequate forage for their permitted sheep. That study also noted that of 3984 acres, only 1915 acres (48%) were suitable for livestock grazing. It further stated that 95% of the forage was fully utilized and that very few palatable plants were left to decompose over the winter.

In 1930, the permitted numbers dropped to 3710 sheep and 3300 lambs. In 1933, it appears this number dropped to 1,000 sheep in the upper JRW for a season of July 1 through October 15. It is our assumption a comparable number of lambs were also permitted. Through the remainder of the 1930's, approximately 2-3,000 sheep and a comparable number of lambs were permitted. By the early 1940's, the number of sheep dipped below 2,000 sheep and a comparable number of lambs. In 1956, grazing in the upper portion of the watershed was drastically reduced and in 1960, it was eliminated.

The earliest record of the Jarbidge Local allotment was 1932. We assume that this area was grazed in the late 1800's as was the case in the upper watershed. Partial records indicate that sheep were removed from the lower drainage in the early 1900's. Existing records would indicate that this allotment was in use until 1972. This allotment had a history of use which included 20 to 40 head of horses and milk cows owned by Jarbidge residents and allowed to graze free of charge. It would appear that this use varied from year to year until it changed sometime between 1946 and 1956. At that time, the permitted numbers and season were changed to 6 horses for the period of June 1 to October 31.

The only portion of the JRW currently permitted for livestock is in the Jack Creek drainage located in the Dave Creek C&H allotment. This allotment is under improved management and a rest rotation grazing system. Additionally, the Forest Service grazes horses in a small area around the Mahoney Administrative Site. This use is variable and has not occurred on a yearly basis. Average use has been 6 horses for a month to month and a half during the early spring.

Documented and speculative impacts of intensive sheep grazing are well reported in the literature, and will not be discussed at length in this document. Wilson's observations imply that extensive and possibly detrimental sheep grazing occurred in the upper reaches of JRW prior to and following the formation of the Forest Reserve. Our principle concern in this analysis is the effect of sheep grazing on the morphology and function of the Jarbidge River.

The most likely area(s) of conflict in the upper Jarbidge Watershed are certainly the ***source*** channels and hillslopes as described in Chapters 1 and 3 of this document. The source area of the JRW is not suited to domestic livestock use. It is probable that significant changes to plant communities represented on these slopes occurred through intensive grazing and trampling, and that the rate of down slope soil movement increased as a result. Additional down slope soil movement may ***contribute*** colluvium to the ***debris torrents*** that emanate from Snowslide, Dry and Bonanza Gulches on a periodic basis, but it is unlikely that intensive grazing is the causal mechanism behind these debris torrents. A thorough review of aerial photography strongly suggests that debris torrents were a frequent erosional feature of the upper Jarbidge Watershed long before the introduction of domestic sheep, though the intensity or magnitude of prehistoric events are extremely difficult to quantify. This hypothesis is supported by professional knowledge of similar situations and the large number of sheep grazing the upper drainage early this century. It is felt this combined with other resource extraction activities to negatively impact watershed health until grazing was eliminated in 1960.

It also seems unlikely that potential for a ***debris avalanche*** has increased as a result of intensive sheep grazing. One of the numerous factors that contribute to debris avalanches is the rate and amount of water running through the soil during periods of field capacity or saturation. Although soil compaction has been documented as resulting from excessive livestock grazing, soil textures in the JRW are coarse and not subject to severe compaction from grazing so it is felt the most negative impact to the watershed from sheep use was through vegetation removal. The removal of vegetation and the generally slow permeability of JRW soils are felt to be the most negative impact to watershed health from extensive sheep grazing.

Current vegetation mapping would indicate the removal of livestock in the upper watershed has, at least in part, assisted long term improvement and recovery of watershed health. This is further supported by comparing vegetation expression in the East Fork where fewer human impacts have occurred and activities have been restricted since designation as wilderness in 1964.

Mining: The population of Jarbidge Canyon erupted in 1909 as a result of gold discovery, and mining led local industry until the 1940's. The Jarbidge Gold Rush placed 1500 miners in the canyon bottom for the spring season in 1909, 650 people through 1910, and 200-300 miners and merchants in Jarbidge, Pavlak, Bluster, and the Hub until the early 1930's.

Effects of this intensive occupation are many. The removal of vegetation for house construction and for fuelwood, with human and draft animal trampling, most likely increased soil loss to dust and erosion. It is highly probable that any removal of easily accessible woody material from the river also had the effect of raiseing water temperatures and thereby affecting fish habitat.

Extensive logging appears to have occurred in various places in the watershed. Construction materials for the Norman Mine, in the headwaters of the Jarbidge River, came directly from the headwater canyon area adjacent to the mine. Timber for the *Success, Bluster* and many of the major mines of the 1920's originated in Sawmill Canyon and the headwaters of Fox Creek. Deer Creek Canyon was also logged for mining timber.

By the early 1920's, the Jarbidge Mining District had 10 major operating mines with over 90,000 feet of underground workings and 8 processing mills. Two of these mills, the *Long Hike* (later *Elkoro*) and *Pavlak* were immediately adjacent to the Jarbidge River. Both mills used cyanide in ore processing (cyanidation at the *Long Hike* and cyanide leach at the *Pavlak*), and both dumped processed mill tailings directly into the river (Schrader, 23). Tailings from the Bluster Mill (located on the east bank roughly 120 feet above the valley bottom) were dumped down slope toward the Jarbidge River floodplain. Tailings slopped over into an intermittent drainage directly south of the mill site and run-off during wet periods may have carried tailings into the Jarbidge River. The Bluster Mill site is 2 miles south of the town of Jarbidge.

Mining and water quality: There are indications that the quality of the water in the Jarbidge River has been impacted by human activities since settlement began in 1909. One of the early discoverers of the Jarbidge claims, Dave Bourne, noted that fish were plentiful in the Jarbidge River in 1909 (Mathias and Berry, in press, 97). Twenty-six years later, Biologist S.D. Durrant of the Department of Commerce noted that the Jarbidge River was "... greatly polluted by mine tailings..." starting two miles upstream from Jarbidge town. Mining pollution rendered "... the entire lower stretches (of the Jarbidge River) unfit for fish" (Durrant, 35). The lowest recorded pH value on the Jarbidge River was taken by Durrant in 1934. Durrant observed a pH value of 5.0 and noted that the observation was associated with mining pollution. The exact nature of the pollutants are unknown, and it is likely that habitat modification also contributed to the biological conditions reported by Durrant.

The use of cyanide in the milling and separation operations conducted at the Bluster, Pavlak and Elkoro mill sites is documented by Schrader (1923) and others. Disassembly of the redwood cyanide vats at the Bluster mill and the reuse of the lumber in the construction of stream side "California" homes (at present day Bluster Campground) is documented by Wilson. We can thus demonstrate that cyanide was in use on the banks of the Jarbidge River. Cyanide is highly toxic to aquatic life forms but is comparatively short lived in the environment (Eisler, 91).

Temperature: Three mines are known to have drained effluent into the River. Recorded measurements from 2 of the 3 (Pavlak adit and Greyrock shaft) document thermally elevated water. The Pavlak Mine had "... a strong stream of water that flows from the mouth of the tunnel practically drains the mine ..." in 1922 (Schrader, 23). The 42 G.P.M. flow was 3.4 degrees above the summer monthly mean of 7.6 when measured in September 1996. The Norman Mine had "... a strong stream of excellent water...from tunnel No. 2"(Ibid.). There are no temperature or water quality data available for water discharge from the Norman Mine.

The Greyrock shaft at the Elkoro mill site was sunk to 1300 feet in the mid 1930's and immediately filled with thermally elevated water. Dewatering operations from 1937 through 1941 reportedly dumped over 7 billion gallons of warm water into the Jarbidge River (Camozzi, 42). Given these figures, the discharge from the Greyrock shaft was 31 cubic feet per second (CFS), over *six times the base flow* of the Jarbidge River for a period equivalent to *696 days*. This flow would have dominated the river from August through April, substantially raising the base temperature of the river. This flow could have brought the average temperature of the river substantially above tolerable temperatures for bull trout (18) as described by Shepard (1985).

Effluent from the Greyrock shaft was tested in 1977. At that time the temperature was 24 degrees. We have no record of the volume of flow, but it is thought to be small. Available for comparative analysis are 3 samples that measure water temperature above the town of Jarbidge (and above the Greyrock shaft) and below town on the same day. Two of these 3 samples record temperatures 1.6-2.2 degrees higher below town than above. The third sample records identical air and water temperatures above and below town. Unfortunately, samples from below town were all taken 0.5 to 1.8 hours later in the day than those taken above town, such that some increase in water temperature can be attributed to increased solar input.

Roads: The discovery of gold in the Jarbidge River Canyon spurred the rapid development of access roads into and throughout the canyon. Vehicular access extended to at least Perkins Cabin at River Mile (RM) 18.75; it is reasonable to assume that this road was in service when the Norman Mine was operating prior to 1920. Durrant (1935) noted that: "a road parallels the stream nearly to the source". It is very likely that the Jarbidge Canyon Road from the East Fork confluence to the headwater tributaries (above Sawmill Creek) was well established by the early 1920's.

Upstream from the town of Jarbidge, the original road followed the course of the river, and typically stayed within the meander belt width where the valley bottom was narrow. Evidence in

Figure 4.1a. Upstream from the Bluster Bridge on 03-27-97. Alder lines both banks. Mean stream width (n=4) is 27 feet. Snow in the extreme lower right hand corner of the photo covers wire gabions that hold the river from eroding around the wingwall.

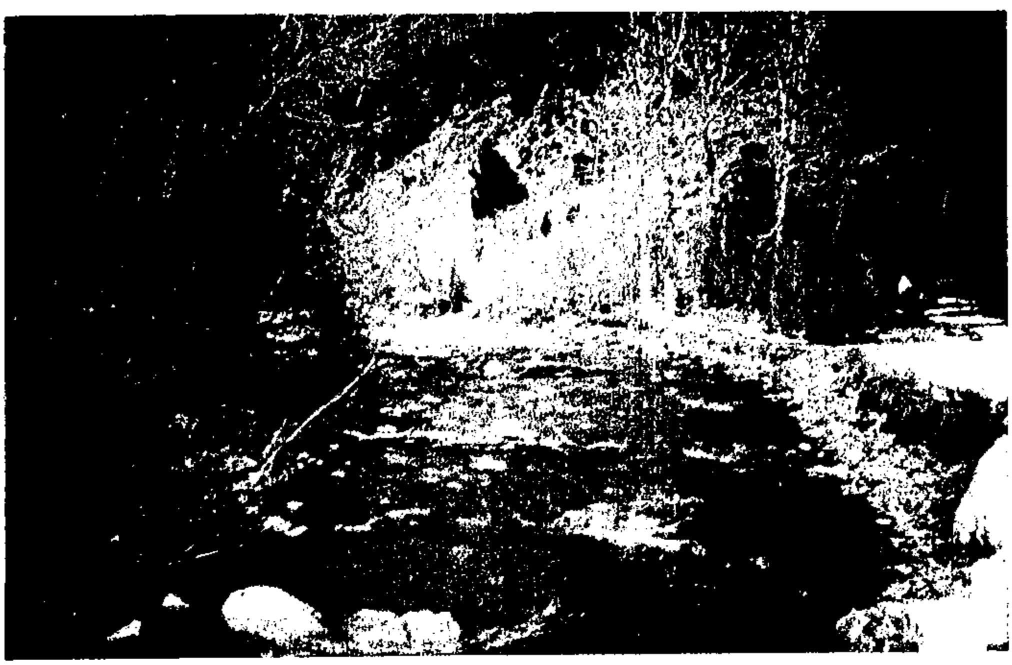


Figure 4.1b. Downstream from the Bluster Bridge on 03-27-97. Mean stream width (n=4) is 43 feet. Note absence of alder or willow on eastern streambank. In the extreme lower right hand corner of the photo are remnants of the bridge that spanned the channel prior to the existing bridge. The 1979 channelization began approximately 70 meters downstream from this point.

the form of abandoned culverts, bridges and visible road paths indicate the road above the town of Jarbidge has been damaged or washed out a number of times since originally constructed. The most recent of these events was the 1995 flood, which destroyed portions of the road between Pine Creek and Snowslide Gulch, then the terminus.

Construction of the Jarbidge Canyon Road (Forest Road #064) and keeping the road in the narrow valley bottom has influenced the morphology and function of the Jarbidge River. We point to two current examples of effects to this river from the Jarbidge Canyon Road.

Example 1: There are 7 bridges crossing the Jarbidge River between the south end of the town of Jarbidge and Fox Creek, a distance of 3 miles. For the purpose of this analysis, we measured the actual river span of 5 of the 7 bridges. The span of these bridges ranged from 26 to 29 feet. We then assembled a data set (N=38) of actual measurements of the channel width from above Fox Creek to below the south town bridge. The average width of the channel within this 3 mile section is 46.5 feet. The widest bridge spans only 62% of the average channel width.

The 7 bridges are not evenly spaced over the three miles. The greatest distance between bridges is between the Bluster Bridge at RM 14.8 and the north Fox Creek Bridge at RM 15.8. With a number of considerations, we hypothesized that the river channel upstream from the Bluster Bridge exhibited the least influence from human activities within the 3 mile reach. Channel width measurements (n=4) above the bridge produced a mean bankfull channel width of 27.1 feet. Channel width measurements (n=4) below the bridge produced a mean channel width of 43.27 feet. Figure 4.1 graphically illustrates the difference in stream conditions above the Bluster Bridge (Figure 4.1a) and below the Bluster Bridge (Figure 4.1b). The river channel is wider, shallower and has less stream side vegetation below the Bluster Bridge than above.

Example 2: We measured the valley bottom width at RM 14.5 at 281 feet. The topography of the valley bottom strongly suggests that the valley bottom width was the same as the meander belt width prior to construction of the road. The meander belt width is now estimated to be roughly 100 feet. Eighty-nine feet on the east side of the meander belt were eliminated by the construction of a dike upstream from the south Pavlak bridge; ninety feet were eliminated on the west side of the meander belt by the construction of a dike below the south Pavlak bridge. The 27.5 foot wide south Pavlak bridge was constructed on a meander bend, and has reduced the meander belt width of the Jarbidge River by about 70% in the one section measured.

Of the 7 bridges in this section, 4 currently are in need of repair. Stream banks upstream from the south Fox Creek, south Pavlak and south town bridges are eroding into the wingwalls. The north Fox Creek bridge, though not completely destroyed, was severely damaged by the 1995 flood.

Vegetation: Impacts to vegetation have been discussed under ***Livestock, mining,*** and to a limited extent ***roads.***

We have reason to believe the vegetative structure of the JRW was altered by humans early in the recorded history of the area. *"It is well watered and there is considerable small timber, although much of this is dead, as the sheepmen, who have had possession of the range for years, burn off the hillsides each year to improve the grazing"(Fisk 1910:763).*

Firewood cutting, mine timbering and road-building in the JRW began with mining booms at the turn of the century and harvest impacted both deciduous and coniferous species. Limber pine was the preferred tree of choice for saw lumber, while most species were used for mine timbers (Schrader, 23). The most heavily cut areas for mine timbers were the headwater slopes near Sawmill Creek and the Deer Creek drainage. Schrader observed that in the early 1920's, the best pine-fir communities occurred on the east and northeast slopes. Mapping of cover types for this analysis would indicate that the pine and fir cover types occupy 21% of the JRW in a randomly mosaic pattern.

Aspen stands visible in 1954 photos were much shorter than the same stands viewed in 1993 photos. Current mapping indicates that aspen occupies 29% of the surface acres in the JRW. This compares with 11% in the East Fork watershed. The JRW is occupied by tree dominated cover types over 53% of it's surface acres compared to the East Fork watershed where 36% of the surface acres are occupied by these same types. In many cases, aspen is considered a seral expression for coniferous cover types. With that basis, the large percentage occurrence of aspen in the JRW would further support the hypothesis that it is a recovering watershed.

Specific information concerning streamside riparian vegetation is lacking (see Chapter 3). Limited monitoring data indicates some differences in current vegetation expression which also relate to our professional interpretation of reference conditions for the JRW. Of data from 17 sites in the Jarbidge River and 13 sites in the East Fork, willow was found at ten sites in both watersheds. Cottonwood was found at 10 sites in the East Fork and at 3 sites in the JRW. Alder is extensive in both drainages. Given equal impacts, we would expect cottonwood to be more dominant in the East Fork watershed because of it's wider valley bottoms and lower gradient. Information on cottonwood reproduction is lacking and giving rise to the possibility that cottonwood is a higher seral expression in streamside riparian areas, it's absence in the JRW may be influenced by ongoing successional change. We also recognize a high probability that the difference in occurrence of cottonwood in the JRW has been affected by the higher incidence of human activity in the watershed.

Channel Morphology: Evidence suggests that the meander belt width and channel wave length were much greater in the geologic past. The terraces associated with these belt widths are about 3 and 9 feet above current bankfull so they correspond to terraces found on most rivers throughout the Western United States and are attributable to historical climatic shifts.

Indications are that the river has been reconstructed or channelized in the past in response to numerous floods (see Coffin, 79). We know that portions of the river were channelized in 1979, 1984, and 1996, and think that channelization has occurred on many additional occasions. We think that dewatering of the Grey Rock shaft between 1937 and 1941 increased bankfull flows by

35%, at least over a couple of years. It also appears that construction and maintenance of the 11 bridges crossing the Jarbidge River has influenced the morphology of the Jarbidge River, at least on a localized level, as has construction and maintenance of the Jarbidge Canyon Road.

Chapter 5 Synthesis and Interpretation of Information V2.3 05-21-97

Chapter 5 attempts to answer the "so what" question posed by the concept of *analysis*. Synthesis of 100 years of human history, sporadic survey and water quality data, anecdotal arguments and individual values is a formidable task. At this point, we view the Jarbidge River as a recovering riparian system. Human impacts to this river appear to have been extreme from about 1885 through 1945, during a period of rapid expansion and later decline of the mining industry and intense sheep grazing in the JRW. Road building, road maintenance and chronic channelization have plagued the Jarbidge River since 1910, and though to a lesser extent, continue to do so today. We must emphasize that current morphology of the Jarbidge River is a product of 90 years of channel and riparian area modification from human activities. It is likely that low bull trout numbers in the Jarbidge River are also a product of this modification.

We have no reason to believe that D and G channels, as defined by Rosgen, were not part of the pre-settlement history of the Jarbidge River. With that thought, G channels that resulted from the 1995 flood and current activities in the watershed may be within the range of natural variability for this system. We do not currently have the mechanism to adequately describe the pre-settlement morphology of the stream channel or the frequency of large scale channel altering disturbances that would constitute deviation from that range of variability. Thus we cannot conclusively demonstrate that current conditions are outside the natural range of variability for this system.

Bull trout in the JRW are a relic from the Pleistocene. They are isolated from all other bull trout populations in the Snake River system. Together, the JWR and East Fork watersheds may constitute a metapopulation, though exchange between these populations has not been conclusively demonstrated. Gathered over a 40 year period, population data is limited; population estimates are based on an extremely small number of samples. Bull trout populations in the JRW and East Fork watersheds may very well be depressed and at risk to management induced (deterministic) or random (stochastic) extinction mechanisms. Existing data are not sufficient to make a valid projection of population viability, and we feel is premature to say that the population of bull trout in the Jarbidge River is stable. Although it has been suggested that the bull trout population in the Jarbidge River was never large, we suggest that habitat modification and mining related pollution may have drastically reduced bull trout numbers from 1885 through about 1945.

Paired watershed analysis was used to examine differences and similarities in the morphology of the Jarbidge and East Fork Rivers with specific emphasis on fish habitat. This method is not without limitations and any data resulting from synthesis of the comparison should only be used as a characterization of the JRW. There are distinct differences between these two watersheds, most specifically the drainage pattern.

Summary: The economy of the town of Jarbidge is based on tourism. Tourists visiting Jarbidge come to view the cultural history and to enjoy watershed resources of scenic vistas, wilderness solitude and wildlife. Use of wildlife in the JWR is both consumptive and non-consumptive. Public input specific to current proposed activities in the JRW leaned toward providing further recreational opportunity and development. Additional development of recreation facilities, however, may not foster improved watershed conditions, nor do all federally funded proposed activities in the JWR promote improved bull trout habitat. We see a conflict of public values for and in the Jarbidge River Watershed.

Human occupation and use of the canyon will not only continue but most likely increase in both the short term and long term. It is likely that conflict will become more pronounced as demand for goods, services and recreational opportunities also increase.

Although we feel it is a slow process, data presented in this analysis suggests that recovery of the watershed has been ongoing since the mid 1950's. Human activities have continued in the watershed including developed recreation, road maintenance, fuelwood gathering and physical modification to the stream channel. Current activities appearing to have the most impact on watershed health are those that physically alter stream morphology. We have identified concerns with existing bridge design, road location, removal of large woody debris from the stream channel and impacts to streambank stability as key factors affecting the rate of recovery. We also have concern with potential water quality problems stemming from groundwater inputs to the river which negatively influence water temperature and potentially elevate levels of dissolved minerals.

Based on similar flood situations during the spring of 1995, the team estimated the JRW flood as approximating a 30 year event. Flood events of higher magnitude, as would occur in a 50 or 100 year event, could be devastating to downstream developments within the meander belt width of the Jarbidge River. Stream straightening, channelization, removal of channel roughness (woody debris, boulders) and alteration of the narrow river floodplain increases the risk of damaging water flows during high water events. Any proposal for ground-disturbing or channel modifying activities above current levels should trigger extensive analysis.

Existing bridges and the Jack Creek culvert are known to have impacts to natural stream dynamics and hydrologic processes. The Jack Creek culvert has been identified by the Jarbidge Bull Trout Task Force to be a barrier to upstream fish migration. Standards and Guidelines developed by INFISH and adopted by the Humboldt LRMP include consideration for constructing new or replacing existing road system structures where they pose *substantial risk to riparian conditions*.. We feel that the barrier to migration posed by the Jack Creek Culvert greatly impacts bull trout in the JRW, and consider this structure a *substantial risk* to bull trout in this system.

As demonstrated in Chapter 4, other bridges in the JWR affect riparian conditions by directly reducing streambank stability and indirectly increasing stream temperatures. These structures appear to be retarding attainment of Riparian Management Objectives, and thus also fall within the *substantial risk* criteria as determined by INFISH.

This analysis was based on the best available information, professional knowledge and an extensive search of current literature.

Chapter Six: Recommendations

This chapter provides Deciding Officers with interdisciplinary recommendations for planning and implementation of future projects within the JRW. It also provides recommendation for management efforts and restoration of natural dynamics. They are designed to be responsive to the two key questions driving this analysis (see Chapter Two for key questions). The following recommendations *are not* presented in order of priority:

1) **Proposed activities in the *source area* should trigger extensive analysis during future NEPA analysis.**

2) **Each bridge in the upper watershed should be evaluated for the current effect on the hydrologic regime and aquatic habitats.** The Forest should pursue long term solutions to mitigating or eliminating effects from the road and bridges to stream dynamics on the Jarbidge River.

3) **The Forest should explore all options for relocating developed facilities outside the meander belt width of the Jarbidge River.** The long term maintenance of these facilities is potentially cost-prohibitive given the destructive impact of natural stream dynamics.

4) **The Forest should explore long term options for relocating any existing portion the Jarbidge Canyon Road out of the Riparian Habitat Conservation Area.**

5) **The Forest should, in corporation with Elko County and the Bureau of Land Management, develop a road maintenance plan designed to reduce impacts to the Jarbidge River.**

6) **The Forest should develop a comprehensive recreation plan that is responsive to projected increases in recreation pressure.** This plan needs to explore opportunities for development outside Riparian Habitat Conservation Areas.

7) **The Forest should emphasize retention of large wood and timber throughout the Riparian Habitat Conservation Area.** Any proposal for removal should be coordinated with fisheries and hydrology specialists with prime emphasis on stream hydrology and habitat values

8) **The Forest should, in cooperation with the State of Nevada, conduct an intensive survey of the river basin for hazardous materials and conditions, and pursue cleanup where needed.**

9) **The Forest should evaluate necessary actions for restoration of the existing dump site.**

10) **This analysis indicates that the INFISH Riparian Management Objective (RMO) for width/depth ratio should be modified.** Recommend that the RMO be 30 feet or less.

11) **The Forest should sponsor an interagency public information program dealing with**

natural stream dynamics specific to the Jarbidge River.

This chapter also provides a listing of data shortcomings as identified by the IDT. In all cases, data was used as appropriate either in making direct inference or as a characterization of conditions in the JRW. We recognize that this analysis was limited by available data and where appropriate so noted in chapter write-ups. The following are suggestions for data collection which will help to further define recommendations made in this analysis:

1) Conduct an interagency *limiting factor analysis* for bull trout, using the R4 basin survey protocol as the foundation of the analysis.

2) Install temperature devices to characterize long term temperature profile.

3) Develop documentation of stream flow data through cooperative efforts with Jarbidge residents or the installation of a gauging station.

4) Explore long term opportunities for third order soil survey.

5) Through R4 Basin Survey, greenline, or other recognized protocol, develop better database on stream side riparian vegetation.

Errata: figure 3.5 on page 3.9 compares temperatures between the East Fork and Jarbidge Rivers. The legend was omitted from this diagram. Bars on the right side of each column depict temperature on the East Fork River. Bars on the left side of each column depict temperature on the Jarbidge River.

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